POWER

Volume 64 New York, September 28, 1926 *Number* 13

Wages and Prices

Unless industry can so manage itself as to keep wages high and prices low, it destroys itself, for otherwise it limits the number of its customers—
Henry Ford.

AS I have frequently pointed out on this page, practically every necessary and legitimate charge that goes into the cost of a commodity or a service is reducible to human labor.

If the cost of the labor involved in producing and distributing an article is doubled, the price if it is fixed by the cost will be doubled. If this occurred simultaneously to all products and services, the doubled wages would be worth no more, for they would have no more purchasing power.

When labor began its organized struggle for more pay and better conditions, eight or ten dollars for a day of eight hours would have looked like the millennium. Almost anybody would have said that if he could get that he would be eternally satisfied.

But the greatly increased wage per hour procures little more of the good things of life than the smaller used to, and the struggle is still on.

Some more, yes. The laborer has more leisure. Conveniences, comforts and amusements are accessible that were not to be had fifty years ago.

But this has been done not by diverting to the payroll of the wage earner money which would otherwise be collected in profits. Profits are as great as ever. Fifty years ago a millionaire was a wonder. Now we have over eleven thousand of them in the United States, most of them with several millions, and a billionaire to boot.

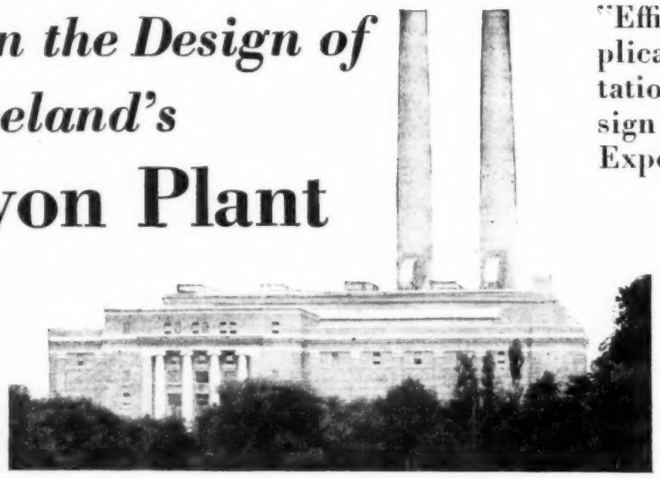
It has been done by increasing the efficacy of our man power by the use of better tools and machinery, by the vastly increased use of mechanical power, by the discovery and adaptation of new materials, methods and processes.

High and low are relative terms. The only way that there can be at the same time high wages and low prices is by reducing the man-hours necessary to produce a commodity or service and by the suppression of excess profits.

When labor works at its greatest efficiency with the least waste of time and material, and price is based on cost plus a fair profit, the wage earner will get the greatest return in the purchasing power of the day's work.

Henry Ford, once a power-plant engineer, has made himself one of the world's richest men by the practical application of this fact.

High Spots in the Design of Cleveland's New Avon Plant



"Efficiency Without Complication or Experimentation" Keynote of Design Which Capitalizes Experience with Lake-Shore Plant

ON AUGUST 4th was officially opened[1] the first section of the new Avon Power Plant of the Cleveland Electric Illuminating Company. Situated on Lake Erie at Avon, 23 miles west of Cleveland's public square, this station has an ultimate capacity of 300,000 kw., two-thirds of which can be accommodated in the present building. The installed capacity is 70,000 kw. in two units conservatively rated at 35,000 kw. each.

Most of the large power stations recently completed have been of interest because of their departures from established practice. The usual has become unusual, and in this lies the significance of the Avon design. It involves some relatively new features, but none that has not been tested sufficiently to insure reliable operation. The ideal ever before the designers was reliability in operation. Eccentricities have been avoided, as have certain practices now generally looked upon as fairly well established, but which, in the opinion of the designers, involve more complication than is warranted by the gain in efficiency they afford.

Equal consideration has been given to the lowered investment per kilowatt made possible by simplified design. Finally, architectural beauty has been looked upon as a matter of practical importance.

[1]See account of opening in Aug. 10 issue of *Power*.

The building of large new power plants has become such a common occurrence that the space required for a detailed description of the Avon station would hardly be justified. This article will make no attempt to describe the station completely. The plan is rather to outline briefly the design of the plant as a whole and then to study in somewhat greater detail the features of particular engineering interest—namely, those in which this installation differs from most of the new stations that have recently been placed in operation. An attempt will be made to give the engineering reasons for these decisions.

The ultimate plan contemplates six generating units. The present building has space for four of these. While the two units now installed are rated at 35,000 kw. each, the width of the turbine room is such that future units may be 50,000 kw. if desired. Each turbine is equipped with a 42,000-sq.ft. single-pass surface condenser. There are four 30,600-sq.ft. double Stirling-type boilers, two arranged to serve each turbine.

The Avon plant is designed to use Pittsburgh No. 8 bituminous coal. On a dry basis this runs about 12,500 B.t.u. per pound with about 14 per cent ash and 3 per cent sulphur. The average moisture content is about 6 per cent.

Pulverized fuel is used exclusively, the coal-prepara-

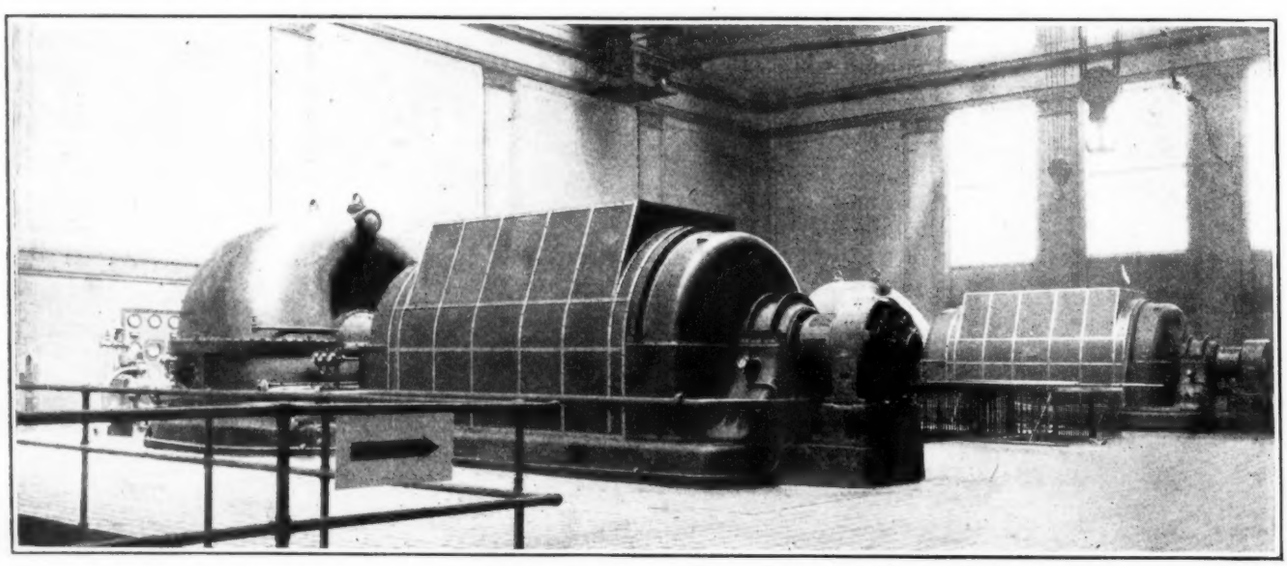


Fig. 1—Two 35,000-kw. units are now installed. The ultimate capacity will be 300,000 kw.

tion equipment being housed in a section of the boiler house rather than in a separate building. Coal is supplied to a 275,000-ton storage yard by the company's own railroad with three trunk-line connections. Drag scraper and skip hoist are used for storing and reclaiming. Coal is delivered to a large receiving hopper by a car dumper, then carried by skip hoist to a Bradford breaker. It next passes over magnetic separators to the skip hoist for elevation to the top of the coal-preparation plant. After traversing another set of magnetic separators, it is distributed by belt conveyor to the overhead crushed-coal bunkers. The present equipment can handle 250 tons an hour. Future extensions of the station will require only a lengthening of the distributing belt. The entire coal-handling system is motor driven and electrically interlocked to prevent clogging.

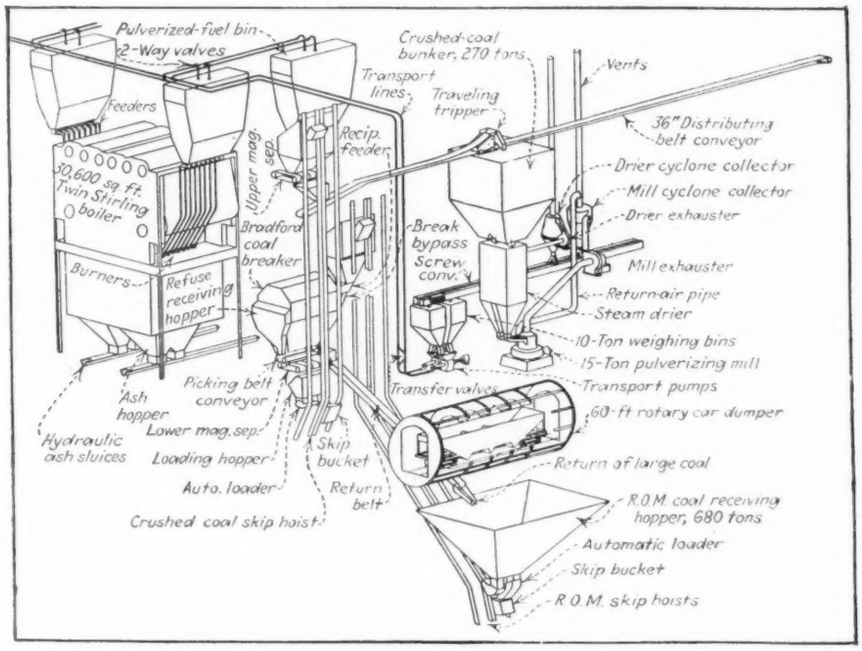


Fig. 2 — Isometric sketch showing how coal is broken, pulverized and delivered to boilers

After passing through a steam-heated drier, which reduces the moisture to 3 per cent, the coal is pulverized in four 15-ton, 6-roll impact mills. The powdered coal is exhausted into a cyclone separator and transported to weighing tanks by screw conveyors. It is then pumped to the bunkers above the boilers.

Each boiler has 16 fan-tail burners, 8 on a side. The boilers, which are of particular interest, will be described later in the present article. The ashes are discharged through air-operated gates to a hydraulic sluiceway.

Feed water is supplied by three turbine-driven centrifugal pumps. Each condenser has two circulating pumps, one motor driven and one with dual drive (turbine and motor). Similar drives are employed on the two condensate pumps. The house-service pump is turbine driven. Steam air ejectors are used. All other auxiliaries are motor driven.

The Lake Erie water runs about 7 grains hardness per U. S. gallon. Makeup will be low, probably not over 2 per cent. This is due in part to the small amount of steam-driven equipment, and in part to the fact that the overflow of surge tanks is trapped back into the system. No water softening is employed on the makeup. Feed-water regulation is by hand.

Starting at the condenser hotwell, the feed water is heated in succession by generator air cooler, steam air ejector and by steam bled to a closed heater from the fourteenth stage of the main unit. It is then elevated to a small barometric condenser which receives steam from the auxiliaries and acts as a deaërating heater. From this it passes through venturi meters to the boilers. High-pressure steam and water piping consists exclusively of seamless steel tubing with cast-steel valves and fittings and Van Stone flanges. Motor operation with distant and local control is provided on the boiler and turbine main stop valves.

With this brief and partial description of the plant attention may now be turned to features of particular interest. First comes the matter of architectural appearance. The plant rests in a setting of natural beauty at a point where it is seen by thousands of motorists passing on the main highways to Toledo and points west. Under the circumstances a substantial expenditure would have been warranted to give the station a dignity of design commensurate with its importance to the community. As a matter of fact it was found possible, with competent architectural assistance, to give the plant a most pleasing appearance both inside and out without adding appreciably to the cost.

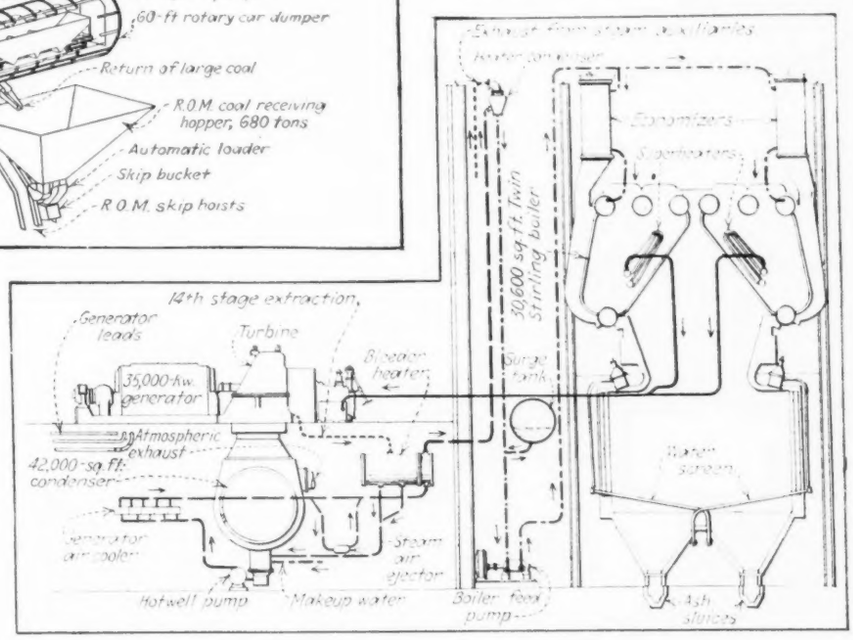


Fig. 3—Flow diagram showing method of feed heating

Units of 35,000 and 50,000 kw. were considered. The former were selected for the first installation because the larger units, with only two installed, would have operated at an uneconomical load for several years. The

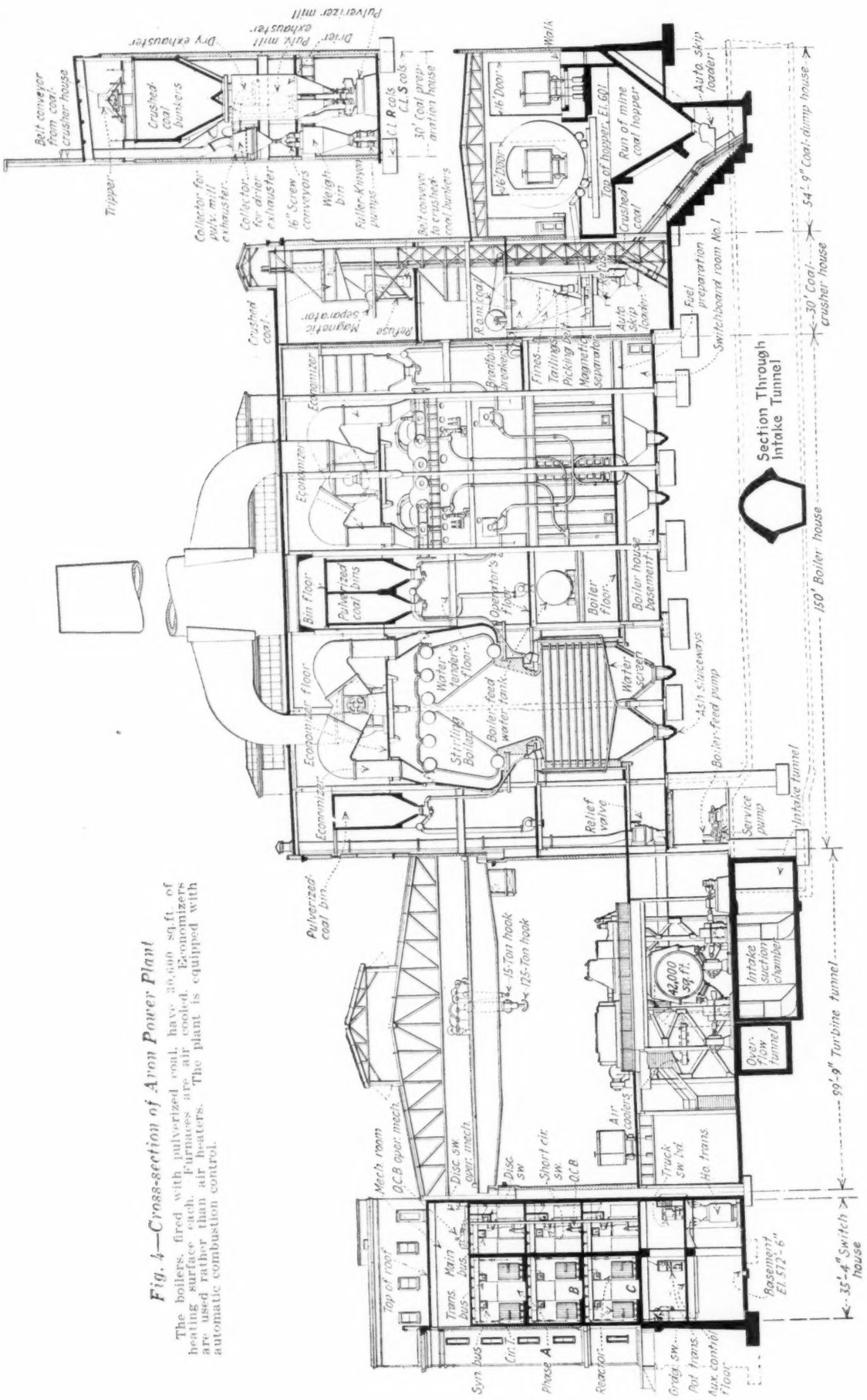


Fig. 4—Cross-section of Avon Power Plant

The boilers, fired with pulverized coal, have 20,600 sq.ft. of heating surface each. Furnaces are air cooled. Economizers are used rather than air heaters. The plant is equipped with automatic combustion control.

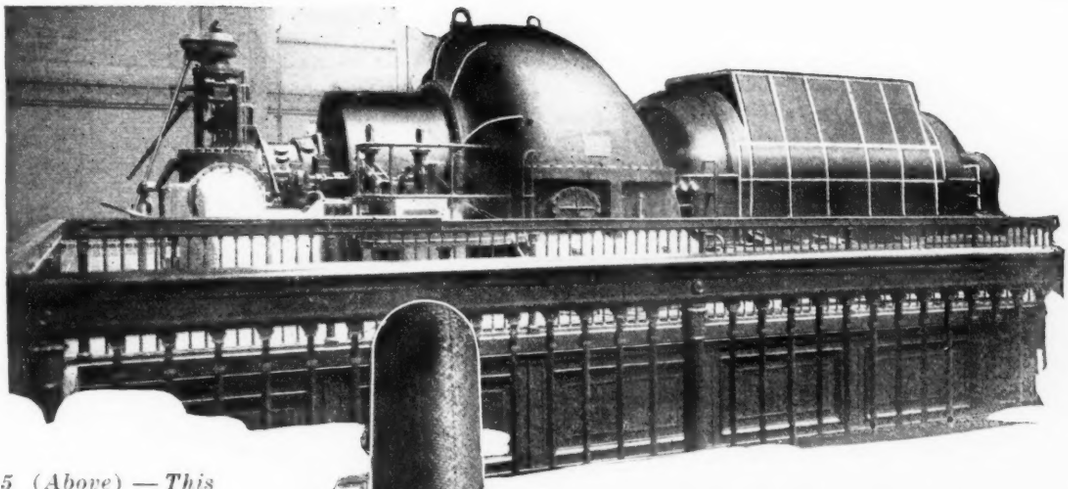


Fig. 5 (Above) — This 35,000-kw. unit was started Aug. 4

Fig. 8 (Below)—Each condenser has two circulating pumps, one motor driven and one duplex driven

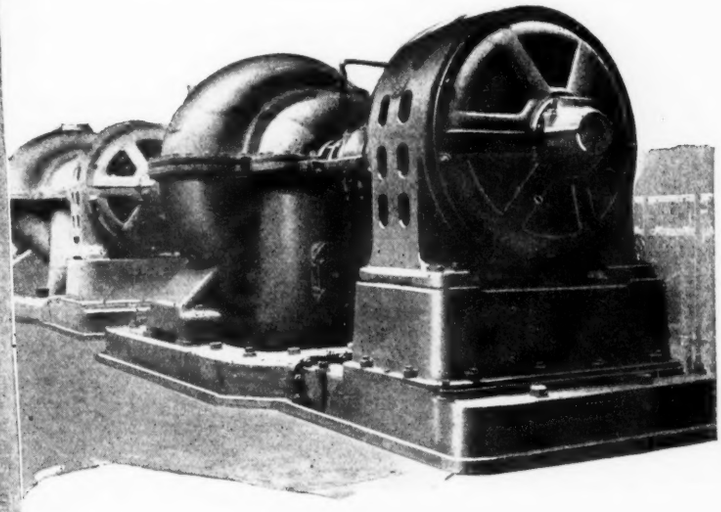


Fig. 6 (Right) — Each brick stack serves two boilers and one turbine. The ultimate plant will have six stacks

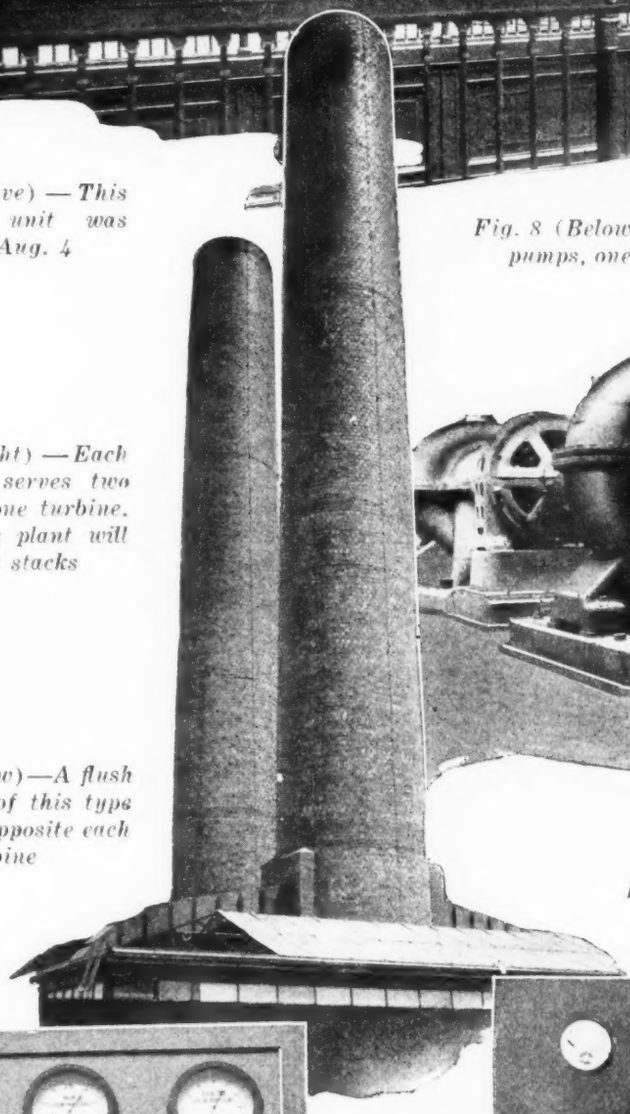


Fig. 7 (Below)—A flush gage board of this type is mounted opposite each turbine

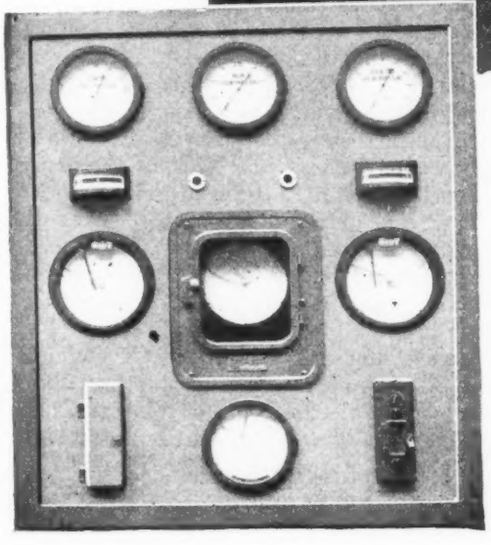
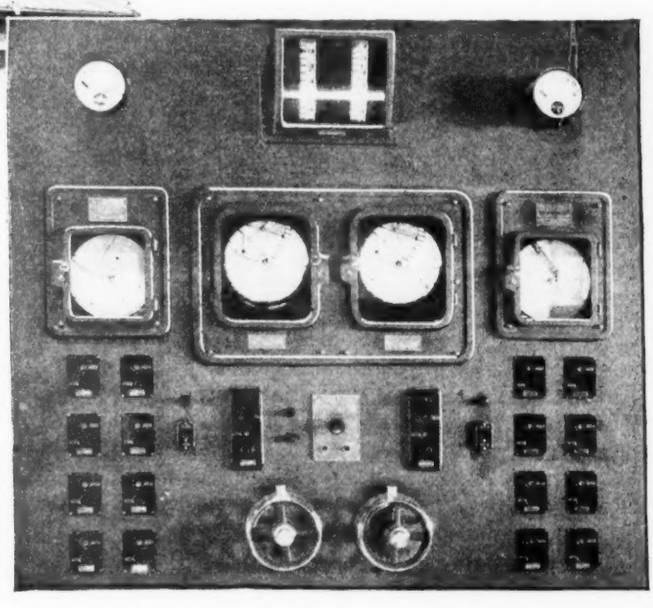


Fig. 9 (Below)—Combustion control board at end of row of boilers



present Lake Shore station is efficient, and it is not planned to favor Avon with a base load. Incidentally the system is not yet large enough to absorb the loss of a 50,000-kw. unit from the system.

The size of the turbines having been fixed, the next question related to the number of boilers per turbine. A single boiler was naturally out of the question. Two boilers would be satisfactory if the size and maximum rating could be such as to carry the turbine with one boiler in an emergency, and if at the same time good efficiency were obtainable with both boilers operating at a lower rating. It so happened that the boilers already in use at the company's Lake Shore plant almost exactly fitted these specifications. Their operating

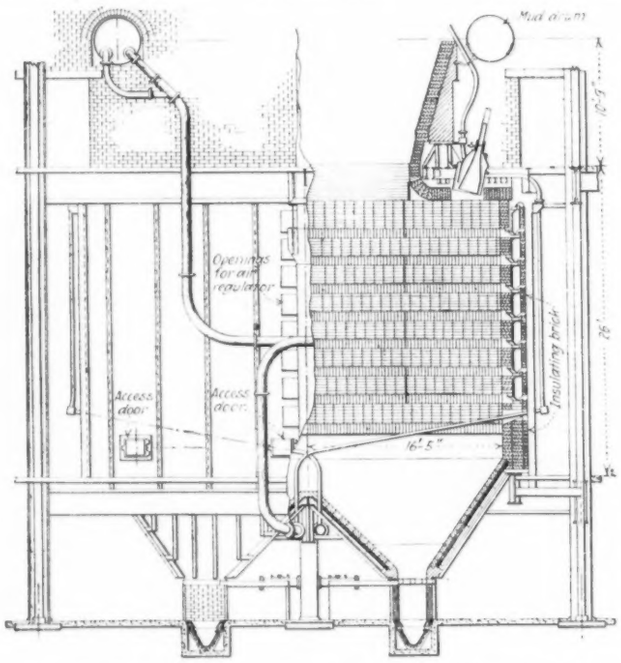


Fig. 10—Cross-section of furnace showing air-inlet zones. No water cooling is used

characteristics were thoroughly understood and their efficiency curves were a matter of test and record.

Under the circumstances the selection of similar units for the new plant was an extremely satisfactory proposition from the viewpoint of operating reliability and incidentally of efficiency as well. The Lake Shore boilers are of the double Stirling type with 30,600 sq.ft. of heating surface.

They are fired with pulverized coal and equipped with economizers and automatic combustion control. The furnaces are air cooled with a water screen at the bottom. The combustion control at Lake Shore is adjusted to give a practically constant flame temperature of about 2,500 deg. F. at all ratings above 100 per cent and a CO_2 percentage ranging from 15 per cent at 100 per cent of rating to 14 per cent at 300 per cent of rating. A flat efficiency curve is obtained which lies above 90 per cent and from 50 per cent rating up to 275.

In spite of the high CO_2 and the fact that the furnace walls are without water cooling, little trouble has been experienced with refractories.

In January, 1925, similar boilers were installed in the new Twentieth Street heating plant of the Cleveland Electric Illuminating Company. In these boilers, however, the air-cooled walls were built of blocks suspended on hangers, a type of construction commonly used for furnace arches, but new in its application to walls. With this type of wall blocks can be quickly replaced in any section without disturbing any large portion of the wall.

In view of this satisfactory experience it was decided practically to duplicate the Lake Shore boilers at Avon, using identical heating surface (30,600 sq.ft.) and practically the same economizer surface (21,120 sq.ft. in two units). The furnaces were built somewhat higher, bringing the furnace volume up to 30,600 cu.ft. This was done to insure complete combustion and absence of smoke. The suspended type of wall tried out at Twentieth Street was adopted at Avon. The Avon boilers are equipped with automatic combustion control as at the Lake Shore plant.

There are sixteen burners, eight on a side. Special baffles on the end burners prevent erosion of the walls by flame impingement. Tube slagging is guarded against by the water screen. This is connected directly into the water circulation of the boiler, the designers having found at Lake Shore that the use of amply large downcomers and risers overcomes the troubles with burned screen tubes caused by insufficient circulation. These troubles have led in some plants to the use of separate drums for the water screens.

Automatic combustion control was installed because experience at Lake Shore has demonstrated its ability to insure operating results substantially the same as those obtainable on test.

Economizers were installed because they were found to give a worth-while return on the investment. Air heaters were considered, but it was felt that their use with air-cooled walls would be somewhat experimental at the present time. Steam pressure and temperature were increased to what might be described as the maximum conservative values of present-day practice. Experience at other plants indicates that no trouble should be expected with the selected boiler pressure of 400 lb. and temperature of 725 deg.

The corresponding conditions at the turbine are 375 lb. and 700 deg.

The boilers are equipped with steam-flow air-flow meters and instruments to indicate the usual draft pressures and temperatures of steam, water and gas. There is a venturi meter on the line to each group of two boilers and on a third emergency line, which may supply either group.

There is nothing unusual about the turbines to warrant special discussion. A single-pass condenser was selected after considering the greater cost of pumping on the one hand and the lower investment cost (due to smaller size) and higher vacuum on the other.

The choice of the method of heating the feed water was influenced by the use of an economizer, by the desire to secure the utmost simplicity, and by the availability of exhaust from turbine-driven auxiliaries. It was decided that one stage of bleeding was all that was warranted at the start, but a second bleed point was provided for possible future use. The feed-water cycle, which has already been outlined, is shown in Fig. 3.

Acknowledgment is made to John Wolff, mechanical engineer of the Cleveland Electric Illuminating Company, who supervised the design of the Avon plant, and to his assistant, A. A. Casey, for co-operation in making available the information upon which this article is based.

*Boiler Feed-Water Purification—XIII**

Corrosion—Its Cause and Cure

Millions of Dollars Are Wasted Every Year by the Corrosion of Boilers, Economizers, Heaters, Condensers and Piping. This Article Explains Why and Describes Practical Remedies

By SHEPPARD T. POWELL
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CORROSION of ferrous and non-ferrous metals in all industries is enormous despite the earnest endeavor of a great number of investigators to control these losses. The factors that influence corrosion of metallic substances are numerous and, for this reason, difficult to control. The investigations of this subject during the last few years have thrown much scientific light upon the fundamental principles upon which corrosion proceeds.

While corrosion of metals may not be completely eliminated, the problem can be controlled in most cases. This may be accomplished: (a) By careful processing in the manufacture of the metal, (b) by preservation of the surface as a result of protective coatings, (c) by controlling the substance coming into contact with the metallic surfaces. In the present article the discussion on this subject will be confined primarily to the last two phases of the problem, since it is these which are intimately related to feed-water treatment.

In the case of boiler and auxiliary equipment high temperatures and pressures are factors in the acceleration of corrosion that are present to a lesser degree or not at all when the corrosion proceeds at atmospheric temperature and pressure.

The resistance of non-ferrous objects (such as condenser tubes) to corrosion is related closely to the composition of materials used and is the most important single factor to be considered. Non-condensible gases released from water in boilers are probably the greatest single agency to be considered in the corrosion of boiler tubes and drums and the corrosion of economizers and superheaters.

Theories of Corrosion

During the last century many theories have been proposed to account for failures due to corrosion. The acid theory was put forward more than fifty years ago and for a time had many supporters. It was contended by those who advanced this theory that three factors influence the phenomenon, namely, an acid, water and oxygen. Experimental studies have shown the acid theory to be not entirely sound, since corrosion can proceed rapidly in the absence of carbonic acid or other acid provided the metal is in contact with water containing oxygen.

The biological, the film, the peroxide and the direct-oxidation theories have been conceived by different investigators. These may account for the corrosion phenomenon that takes place in specific cases, but they are not sufficiently broad to indicate the basic or fundamental conditions upon which the corrosion of metal proceeds.

The electrochemical theory was suggested about twenty years ago by Whitney and has since been confirmed by a number of other investigators. It is now accepted generally as a sufficiently satisfactory explanation of the basic reactions that are responsible for the corrosion of ferrous as well as non-ferrous metals. The theory is somewhat complicated and involved. Briefly, however, it may be explained as follows:

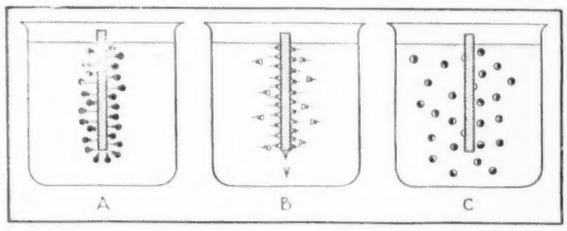


Fig. 1—Electrolytic theory of corrosion illustrated

A—Iron ions passing into solution. B—Hydrogen ions depositing on the iron, polarizing (blanketing) the metal. C—Oxygen dissolved in water removing hydrogen by uniting chemically to form water. This permits more iron to pass into solution.

All metals in contact with water have a specific solution tension, that is, they exert the power to go into solution. When this reaction takes place, the metal that has dissolved in the liquid is in the form of ions.[1] This action may take place when the metal and water are chemically pure. Under these conditions the rate at which the metal dissolves is very slow. The solution tension is influenced greatly by impurities in the metal and in the electrolyte.[2] The solution of pure iron in water according to this theory takes place as follows:

Iron dissolves only by displacing another metal that is already in solution in the electrolyte. This may be noted by submerging iron in a copper solution. When this is done, the iron goes into solution in the electrolyte and the copper is deposited upon the iron.

*Previous installments have covered the following subjects: July 6, "Natural Waters and Their Impurities"; July 13, "Getting Rid of Impurities by Sedimentation and Coagulation"; July 20, "Filtration by Gravity and Pressure Filters"; July 27, Softening Water by Chemicals"; Aug. 3, "Hot Process Continuous Softeners"; Aug. 10, "Zeolites Explained"; Aug. 17, "Where Zeolites Fit In"; Aug. 24, "Boiler Compounds"; Aug. 31, "Priming and Foaming"; Sept. 7, "Embrittlement—What Causes It"; Sept. 14, "Evaporators, Their Design and Operation"; Sept. 21, "Getting Rid of Dissolved Gases by Deaëration."

[1] Atoms or atom groups carrying charges of static electricity. If the ions have a positive charge, they are termed cations and if they carry a negative charge, anions.

[2] When the metal is in contact with water, the water is the electrolyte.

Water (H_2O), when ionized, forms hydrogen ions $\overset{+}{H}$ and hydroxyl ion $\overset{-}{OH}$. The iron in contact with the water goes into solution as ferrous ions, and an equivalent number of hydrogen ions (the hydrogen being considered a metal) are discharged and plated out upon the surface of the iron. The ferrous ions in contact with the $\overset{-}{OH}$ ions form ferrous hydroxide. In the presence of oxygen ferrous hydroxide is oxidized to ferric hydrate (ordinary red rust).

When the hydrogen deposits upon the surface of the iron, the metal is polarized and no further corrosion of the iron results until the layer of this gas is removed. In the presence of oxygen the hydrogen is removed, combining chemically with the oxygen to form water. The hydrogen may be removed also by passing away as a gas. In these ways the hydrogen is removed as it forms and the corrosion is progressive.

In the presence of oxygen the iron that has gone into solution in the water in contact with the metal is readily oxidized, forming the insoluble compounds known as rust. When rust deposits form on iron, the corrosive action is somewhat retarded since these may act as a protective coating. Corrosion of iron is not entirely prevented, however, by these rust deposits.

Practically all natural waters contain oxygen and as such are corrosive to a greater or lesser degree. As has been stated previously, the rate of solution is affected by the impurities in the metal and in the electrolyte. Because of these facts, the solution tension is considerably different at different portions of the material. The solution tension is increased in some areas and decreased at others. Owing to these conditions electric currents may flow from one area to another, the electrolyte serving as the conducting medium. This is equivalent to the action of an ordinary wet-cell battery. The metal passes into solution in the electrolyte at the electro-positive areas (the anode), the hydrogen ions migrating to the negative areas and the hydroxyl ions to the positive area.

Dissolved Oxygen and Corrosion

From the foregoing discussion it will be noted that oxygen dissolved in water has considerable effect in accelerating corrosion. The effect of dissolved gases in accelerating corrosion and the problem of oxygen removal has been discussed in the article dealing with deaërators. The rate at which corrosion proceeds in boiler waters containing a specific amount of oxygen will not be the same in all cases. This condition is influenced by the hydrogen-ion concentration of the water (acidity), the incrusting solids in the water supply, the method of operation of the boiler and many other factors, all of which affect to a marked degree corrosion losses.

Corrosion Due to Mineral Acid

At times feed-water supplies are contaminated by mineral acids or, stated more accurately, the non-oxidizing acids. In this class are hydrochloric, nitric, sulphuric, acetic and other acids which are present at times in surface water in appreciable quantities as the result of trade waste discharged into the feed-water supply. Mine drainage is responsible frequently for the acids in feed water, since many mine waters have a high acid content. The presence of these so-called "strong acids" causes rapid destruction of boilers, the corrosion appearing in the form of pitting, which, if not checked, rapidly destroys the metal.

[3]For the purpose of illustration the formula for water may be written HOH which ionizes to $\overset{+}{H}$ and $\overset{-}{OH}$.

Alkalinity of Water and its Effect on Corrosion of Iron

The effect of alkalies on the corrosion of iron is clearly stated by Speller in his book which has been published recently. "Alkalies, as is well known, cause a retardation in the corrosion rate of iron, which diminishes to a certain minimum as the concentration of the base increases. This general fact has been well established by experience and tests. In the works of different investigators there is some disagreement, however, about the extent of the inhibiting effect. The lack of agreement is not surprising, as the rate of corrosion is influenced by a number of factors other than alkalinity, such as the film-forming properties of the waters, rate of motion and temperature. Hydroxide alkalinity is much more effective than carbonate or bicarbonate alkalinity."

Carbonic Acid

The most important non-condensible gas next to oxygen considered from the standpoint of accelerating corrosion, is carbonic acid. In small amounts in feed water this gas has no appreciable effect, since there is usually sufficient alkalinity present in the concentrated boiler water to neutralize the acidity produced by the increased hydrogen-ion concentration as a result of ionization of the carbonic acid. Relatively high carbonic-acid content in the feed water or bicarbonates, which will release carbonic acid under the influence of heat, may cause severe pitting of tube or drum of boiler. Even though no corrosion may take place in the boiler, the carbon dioxide discharged from the boiler with steam may cause active corrosion of turbines and auxiliary equipment. Corrosion occurring in steam pipes may be traced frequently to this source.

Some feed-water supplies contain organic acid or organic compounds which, under high steam temperatures and pressure, are converted into acids. These conditions are the result usually of trade-waste pollution of the feed-water source, although they may be present as a result of drainage from swamps or marshes. Most of these compounds are volatile, and therefore particularly objectionable since they pass from the boiler with the steam, causing active corrosion of steam piping and other parts of the system. A case of this kind was investigated by the writer where pollution of a feed-water supply by organic wastes discharged from a mill caused the destruction of steam piping amounting to over $20,000 in one year, owing to the corrosive action of the steam contaminated by organic acids.

Acid Produced from Salts in Feed Water

There are many salts dissolved in water which, under the influence of heat, produce acids. The most important salt in this respect is magnesium chloride. It appears that magnesium chloride breaks down into the hydrate and hydrochloric acid. The acid generated then attacks iron, forming iron chloride. There then follows a further reaction between the iron chloride and the magnesium chloride, forming iron hydrate (rust) and magnesium chloride again.

It will be noted that a relatively small amount of magnesium chloride in a water supply may become a source of active corrosion since the reaction is cyclic and under the above regenerative condition the corrosion cycle may go on indefinitely.

Sodium chloride (common salt) alone is not actually corrosive, but in the presence of magnesium sulphate reacts with the latter to form magnesium chloride. The magnesium chloride becomes actively corrosive unless neutralized by a sufficient amount of an alkaline salt. If the alkalinity is due to caustic soda, the magnesium chloride will react with it, forming sodium chloride and magnesium hydrate, thus inhibiting the corrosive properties of the magnesium chloride.

Magnesium carbonate or magnesium nitrate in the presence of sodium chloride may generate acid, the former giving hydrochloric acid and the latter nitric acid. Silica and sodium chloride in the presence of steam will produce hydrochloric acid and sodium silicate. Although this reaction is possible, it is doubtful if the condition results in boiler waters except under unusual conditions.

Although this condition is found only infrequently, water high in ammonium chloride may cause corrosion of boilers and appurtenances. A case where boilers were seriously corroded from this source was called to the author's attention recently. Many feed-water problems relating to corrosion may be traced to the production of acids due to the reaction of the various salts concentrated in the boiler water.

As a rule, scale formation will reduce corrosion, since the deposited salts mechanically protect the metal and prevent actual contact with the corrosive agent and the metal. Under some conditions, however, corrosion may take place beneath the scale or even under a protective coating which has been applied to protect the metal surfaces. When this action takes place, the corrosion is generally in the form of "pitting" and often progresses without attention.

Prevention of Corrosion in Steam Boilers

Since many factors influence the rate of corrosion, no general treatment may be offered for correction of this trouble. This condition holds true particularly for the destruction of metal of steam boilers. Many forces are encountered under these conditions that are not present where corrosion proceeds at atmospheric temperature and at normal pressures. Summarized briefly, the principal factors influencing steam-boiler corrosion are as follows:

1. The presence of gases in the feed water, particularly dissolved oxygen.
2. The hydrogen-ion concentration (acidity or alkalinity) of the feed water.
3. The velocity of the water passing over the metal.
4. The temperature and pressure maintained in the boiler.

In considering corrosion, preventive methods for deaëration or deoxygenation of the feed water is essential to inhibit pitting or general corrosion of the metal in contact with the feed water. Methods employed for this purpose have been previously discussed in the chapter dealing with deaëration. Irrespective of the other agencies accelerating corrosion oxygen is by far the most important factor to be considered. Not all corrosion will be arrested even when the feed water has been completely freed from dissolved oxygen. Reduction of the oxygen content of the water to one cubic centimeter per liter or less will reduce the corrosive properties of the water greatly. The presence of a given amount of oxygen in one feed water may show no noticeable corrosion, while the same amount under other conditions might be actively corrosive. Under some conditions incrustation will completely arrest corrosion from oxygen in the feed water, even if the oxygen content is excessive.

Reciprocating pumps are responsible frequently for entraining relatively large amounts of oxygen in the

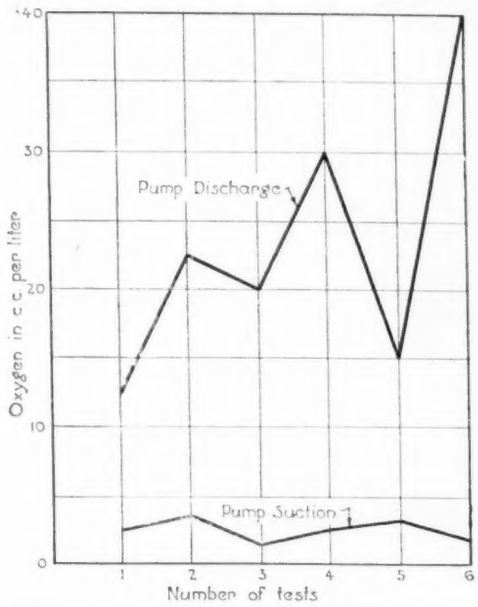


Fig. 2—Effect of entrainment of oxygen in feed water by a reciprocating pump

feed water, after the supply has been deaërated. Contamination of this kind occurs usually with old pumps, and it is often difficult to correct the trouble, since some oxygen is sucked into the pumps even when the packing glands are made as tight as possible. See Fig. 2 which summarizes tests made by the author.

It is a recognized fact that water is dissociated in electric boilers, generating hydrogen and oxygen by electrolysis of the liquid. In electric boilers the electrodes are submerged in the water and the water is the conducting medium for the current, thereby creating a condition favorable for gas production. Attention has been directed recently by a number of investigators to the possible production of hydrogen and oxygen in fuel-fired boilers.

Below 750 deg. F. the amount of gas production by dissociation of water is probably negligible. Above this temperature conditions may occur in which gas production may be relatively rapid. The possibility of the production of hydrogen or oxygen at high temperature has an important bearing on corrosion, embrittlement or other operating difficulties. These troubles may not only affect the boilers, but extend to the superheater, turbine, condensers and elsewhere in the steam cycle.

The hydrogen-ion[4] concentration of a water is a measure of the ionized hydrogen or the active acidity or alkalinity of the water. High concentration of hydrogen ions tends to increase corrosion of metal. Stated briefly, this condition is due to the fact that an increase of hydrogen ions means a higher acidity of the water,

[4] A full discussion of this term will be given in a later article.

which accelerates the deposition of atomic hydrogen. Atomic hydrogen deposits as the iron ions go into solution in the water, and for each ion of metal that passes into solution there must be deposited or plated out one electrical equivalent of hydrogen. Any agency that increases the rate of deposit of hydrogen on the metal permits an increase in the solution of the metal. This phenomenon is influenced by many factors that may not be discussed here, since they are somewhat involved.

It is interesting to note that the ionization of pure water increases with rising temperatures, so that at from 600 to 700 deg. F. water is distinctly acid, as indicated by the hydrogen-ion concentration. This condition is one of far-reaching importance in high-steam-pressure installations. Fig. 3, showing the influence of the hydrogen-ion concentration on the corrosive properties of water at 71 and at 104 deg. F., is reproduced from studies by Whitman, Russel and Altrere.

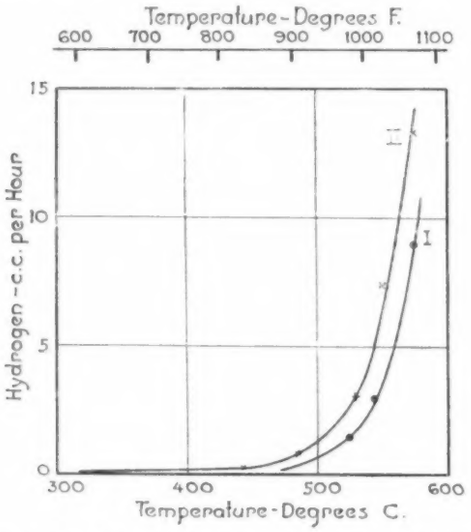


Fig. 3—Effect of high temperatures on hydrogen production in boilers

I—From boiler tubes as supplied. II—From tube which has been heated to over 600 deg. C. and through which CO_2 has been passed (After T. Potter).

It has been accepted, generally, that the velocity of water in passing over metal greatly accelerates the rate of corrosion. There are a number of factors that may account for this condition. Generally, however, the increase in corrosion is due to the fact that the rapid movement of water over the surface brings much greater amounts of oxygen in contact with the metal than would result only from diffusion.

It is common knowledge that hot water is generally more corrosive than cold water. This condition is due to several factors, the most important of which is the release of oxygen as the temperature increases. Under conditions where a fresh supply of oxygen is being constantly released from the water, the corrosion will be exceedingly rapid. Since temperature is only one of many factors to be considered in the mechanism of corrosion, it is difficult to allocate the part it plays.

Hydrogen-sulphide, ammonia, sulphur dioxide and many other gases may be present in surface water employed for feed-water purposes. Of these gases hydrogen-sulphide and chlorine are the most important. The former is present in water generally as the result of trade-waste pollution or from decomposition of sulphate by biological action. Chlorine is at times present due to overdosing water with chlorine solution used in the treatment of public water supplies. Both the gases may accelerate the corrosive properties of water greatly if present in any appreciable quantity.

The majority of boiler-feed-water supplies owe their corrosive tendencies largely to the presence of dissolved oxygen. It is because of this fact that deaëration is the most effective means available for preventing corrosion. No definite limit may be established as to the minimum amount of oxygen that may be present in a supply to insure a non-corrosive water, since complete inhibition is not possible and since many other factors influence the result. Considered broadly, however, the nearer complete removal is obtained, the less becomes the possibility of active corrosion. Deaëration, when accomplished by mechanical means, removes not only the oxygen but other dissolved gases as well. Mechanical deaëration sometimes results in the reduction of bicarbonate to normal carbonate with a material reduction of the hydrogen-ion concentration.

When feed water contains free acids or salts that may be converted into acids under the influence of heat, it should be treated outside the boiler. In the case of non-oxidizable acids these should be neutralized with non-scale-forming alkaline salts. In the case of magnesium chloride, sulphates or nitrates, softening or evaporation of the feed water will correct the potential corrosive properties of these waters. Frequently, however, these salts enter the boiler through leaky condensers. Where such conditions exist, correction of the acidity produced may be effected by treatment of the boiler water with non-scale-forming alkaline salts, by dilution of the boiler water by blowing down or by emptying the boiler and refilling with fresh water.

Adjustment of the hydrogen-ion concentration (acidity) may be obtained most satisfactorily by means of hydrates and carbonates of alkalies. Caustic soda or soda ash is generally employed for this purpose, although in some instances trisodium phosphate or other sodium compounds are preferable. Chromates are used in some cases to inhibit corrosion. Speller points out, however, that chromates are not well adapted for use with boilers since they are affected by heat. The same author directs attention to the fact that chromates react with soluble chlorides, producing hydrochloric acid.

A counter-electrical potential to inhibit corrosion has been used to some extent in this country and abroad, and from a theoretical viewpoint it has merit. A number of installations of this kind have been put into service. There is much still to be learned concerning the practical application of this method.

Conclusions

In years past lack of knowledge of the mechanism of corrosion was responsible in many instances for the rapid destruction of boiler and appurtenances. This condition no longer exists, and many corrosion problems affecting boilers may be reduced to a negligible degree by deaëration of the feed water and by well chosen and efficiently operated feed-water treatment systems. In some respects corrosion problems are more acute than a few years ago. Higher steam temperatures and pressures have introduced new factors that formerly did not exist or at least were present to a lesser degree. Removal of scale-forming solids from feed water has produced a condition favorable for corrosion of boilers in such a case, since the protective coating of scale has been eliminated.

Water Power and Navigation Outstanding Topics Discussed at Basel Conference*

Report of the Sectional Meeting of the World Power Conference Giving Those Features Dealing with the Joint Development of Rivers for Power and Navigation and Development of Hydro-Electric Machinery in European Countries

By R. H. ANDREWS
Paris Representative of Power

ON AUG. 31 the first sectional meeting of the World Power Conference was officially opened, in the historical old city of Basel, Switzerland, under the auspices of the Inland Navigation and Water Power Exposition. Speeches of welcome were pronounced at the opening session by the President of the Swiss National Committee, by the representative of the Swiss Federal Government, and various other officials.

The first working session of the conference took place on Tuesday afternoon. In view of the formidable number of reports presented, the committee had decided to name a reporter general for each division of the different subjects, whose duty it was to abstract all the reports presented on each subject, to call attention to unusual features, and suggest points for discussion. This general report and advanced copies of the individual papers were available for distribution before the meeting, at the opening of which the general report was read in French, English and German. The discussion was then opened.

Discussion Disappointing

In spite of these precautions the discussion at every session palled visibly, from lack of familiarity on the part of the delegates with the subject matter under discussion. One of the reasons for this condition was undoubtedly the almost universal use of the German language in the discussions, which, for lack of time, was not translated.

The subject of inland navigation and the utilization of water power was subdivided under three heads: Generalties and hydraulic installations; machinery and electrical installations; and the development and utilization of water power.

A study of the varied suggestions and opinions expressed in the large number of papers and reports, shows that in Europe they are lacking in a definite policy for utilizing their waterways for power and navigation, the same as in the United States. There were those that held the opinion that power plants supplied from navigable waters should be used only to feed into large transmission networks, so that the output of the plant could be strictly adjusted to reduce to a minimum the interference with navigation. Others were inclined to believe that the disadvantage of using the upper reaches of navigable waterways, as storage for water-power developments, outweighed the economic value of the power, owing to the interference to navigation resulting from the fluctuation in water level.

The thinking on the joint use of rivers for navigation and power developments was apparently influenced by the importance of each in the various countries. For example, in Germany, where water power is not so important in the nation's power supply, the tendency seems to be to subordinate water power to the interests of navigation, whereas in such countries as Switzerland and Sweden, where water power forms a large part of the power supply, navigation is not considered so favorably. Dr. A. Strickler, of Switzerland, speaking on the subject of the "Regulation of Rivers for Power Generation and Inland Navigation," pointed out that in Switzerland, contrary to the conditions in other countries, power is of more importance than navigation and cannot be considered a byproduct of the latter. Navigation must adapt itself to the power demands. Therefore the cost of dams must be charged to the power development, and navigation can be charged only with the cost of locks and other construction specifically applied to its service.

Navigation and Power Carry Equal Importance in Sweden

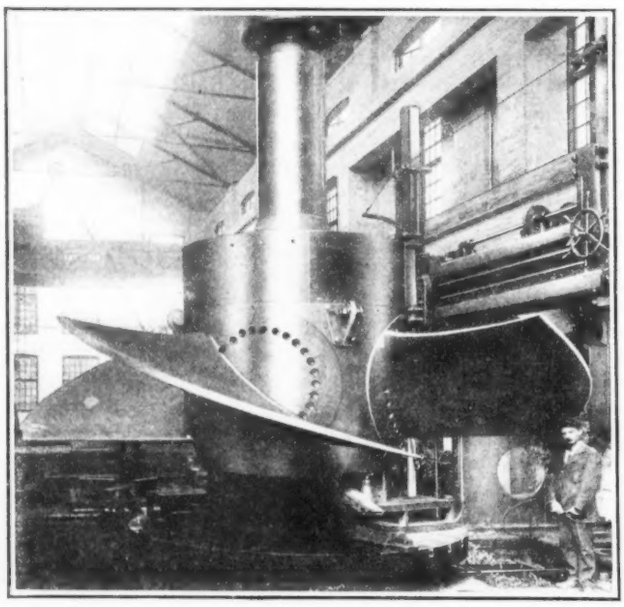
The opinion expressed by A. Ekwall, of Sweden, was to the effect that the two interests, navigation and power, could be combined advantageously on the same waterway. The advantages had been demonstrated in the improvements in the canalized Göta River and the regulation of Lake Vänern, which has benefited both navigation and power. The number of locks has been decreased from 16 to 6, and the head increased slightly on the existing power stations of Lilla Edet and Trollhättan. It is estimated that the regulation of Lake Vänern will increase the available water power from 135,000 kw. in two plants to 255,000 kw. in three plants. In addition to the increase in available power and improvement in navigation from the regulation of Lake Vänern, another gain has been the reduction of ice troubles.

As some of the rivers in Europe are developed for navigation, with a large number of low-lift locks, they are detrimental to the interests of both navigation and power development. One instance of this is on the Seine between Paris and Rouen, described by J. Dupin. It is proposed to eliminate three of the nine locks and dams for the primary purpose of accelerating navigation. This will also make possible the construction of four power plants, two to operate under a head of 18 ft.

*An abstract of Col. Hugh L. Cooper's paper, "Utilization of Water Power and Inland Navigation," presented before the conference, appeared in the Sept. 14 issue. An abstract of the paper, "The Economic Relation Between Electrical Energy Produced Hydraulically and Electrical Energy Produced by Steam," presented before the conference by William E. Mitchell and John M. Gallalee, will appear in an early issue.

and two with a head of 10 ft. The power that can be produced will vary from about 9,400 hp. to 60,000 hp. The annual output is estimated to be 214,000,000 kw.-hr., which can be produced at a cost of 2.4 mills in the 18-ft. head plants and 5.2 mills in the plants with a 10-ft. head. In these estimates the cost of the dams is charged to navigation, which makes the cost of the 10-ft. head plant about $97.50 and the 18-ft. head plants about $50 per horsepower.

The discussion on these subjects had to do with the construction of dams for greater stability and at lower cost, special interest centering on under-pressures. The desirability of finding some means of standardizing dam construction was generally admitted, for the purpose of reducing the cost; but considerable difference of opinion appeared regarding the possibility



Runner for 11,200-hp. propeller-type turbine, with movable blades, installed in Lilla Edet station, Sweden

of attaining this object. It was apparent that electrical and mechanical specialists were tempted to underestimate the difficulty of the problem, whereas hydraulic experts seemed inclined to be pessimistic on the subject.

One of the outstanding points of this discussion was the proposal by H. E. Gruner that the Executive Committee of the World Power Conference propose a pooling of all experimental work and results thereof among all nations, and close co-operation in future research on dam construction, probably through the medium of an international technical committee on dams. It was pointed out by M. de la Brosse that, at the recent hydro-electric convention at Grenoble, France, the same proposal had been made, and that France was preparing to take up the matter through diplomatic channels.

Waterwheel Design

Developments in waterwheel design formed a prominent part of the subjects considered at the conference. A. Ungerer, of Germany, expressed the opinion that under variable local conditions a flat efficiency curve is desirable. It was for this reason that the design of turbine runners had been the subject of a vast amount of research in Germany during recent years. Attention was called to efficiency curves for a Francis turbine.

A 24,000-hp. unit, operating under a 645-ft. head at 500 r.p.m. at the Walchensee plant, had a maximum efficiency of 91 per cent; a 12,700-hp. turbine operating under a head of 85 ft. at 167 r.p.m. had a maximum efficiency of 92.6; and one of 2,950-hp. rating, at 93.75 r.p.m. under a 24-ft. head, had a maximum efficiency of 91.5 per cent. The largest propeller-type turbines with fixed blades in Germany are in the Donau-Kachlet plant on the Danube. These are of 9,320-hp. rating under a 30-ft. head, and have a runner diameter of 15.1 ft. Pelton wheels of 20,000 hp. at 250 r.p.m. under a 630-ft. head and 27,500 hp. at 500 r.p.m. under a 1,170-ft. head are in operation in Germany, the latter at the Schwarzenbach plant.

The Kaplan turbine, which is a propeller-type turbine with movable blades, it was stated, had passed out of the experimental stage, all mechanical difficulties in the blade-shifting mechanism having been overcome. The flatness of the efficiency curve for this type of turbine was emphasized. As a competitor to the Kaplan type wheel, the Francis type with helical gears was taken up, but on account of the lack of sufficient operating data it was considered too early to venture an opinion. It was Mr. Ungerer's belief that the old type of curved draft tube is superior, when correctly designed, to the improved type of straight tubes used in America.

In Sweden the type of turbine mostly used is the Francis, according to Mr. Munding, and on this type the greatest effort has been made to improve its characteristics. American practice of single-runner vertical-shaft turbines with spiral casings is gaining rapidly in Sweden. The recent increases in specific speed are ascribed to the single-runner unit, due to attempting to approach the speed of a multiple-runner unit, with a single-runner turbine of the same capacity.

Much emphasis was laid by Mr. Munding on the Kaplan-type turbine as developed in Sweden. The Lilla Edet Station is now equipped with two propeller-type turbines of 10,000-hp. capacity and one 11,200-hp. Kaplan turbine, all operating at 62.5 r.p.m. under a 21-ft. head. The Kaplan turbine is practically a propeller-type wheel in which the blades are movable, so that the pitch may be adjusted to suit the load and a flat efficiency curve obtained. The runner for the Lilla Edet unit is shown in the figure. It is 19 ft. in diameter, weighs 62.5 tons and developed a maximum efficiency of 92.5 per cent under test in place. It was Mr. Munding's opinion that the success of this type of turbine at Lilla Edet should cause it to come into more general use for moderate heads and large capacities. However, it is considered that possibly the Francis-type turbine, equipped with modern herringbone gears, may be a strong competitor. In the Timsfors plant a 500-hp. propeller-type turbine drives its generator through planetary gears.

In Switzerland, according to A. L. Caflisch, turbines of the propeller screw and Kaplan types have operated at efficiencies of 91 per cent, with specific speed of 200, English units (900 metric). In that country Francis turbines, rated at 17,500 hp. in one runner, have been built for a 920-ft. head, and 50,000-hp. wheels of this type are under construction. At the 160,000-hp. Waggital development 6,600-hp. motor-driven high-head centrifugal pumps are used for pumping water into a storage reservoir during periods when an excess of

power is available. These pumps have an efficiency of 80 per cent.

Dr. A. Wyssling told how in the last 30 years the load factor of the water-power plants in Switzerland had been increased from 12 to about 72 per cent. This has been accomplished partly by commercial policies with regard to rates and partly by interconnection of plants with storage reservoirs with run-of-river stations, so that the most economical use can be made of the water at each type of development. At present 99 per cent of the electrical power generated in Switzerland is supplied from water-power plants, and more than 97 per cent of the population is supplied with electrical energy.

The discussion on water-power machinery started on the question, Why is it that American turbines, according to test reports, show higher efficiencies than similar types of European turbines? Does this indicate better design or construction, or simply a difference in methods of measurement of input or output? An active discussion centered about this question, as yet unanswered. It was proposed to refer the matter of standardizing water-turbine test methods to an international committee. Opinion was divided as to the advisability of nominating a special committee for this purpose, or to entrust it to the International Electro-Technical Commission. Some were of the opinion that the latter had enough to do already, and that hydraulics were distinctly outside its sphere of activities. Others contended that, inasmuch as this commission comprised a prime-movers section, it was perfectly able to handle the matter, by the creation of a subcommittee on turbines. It was finally decided to submit both plans to the Executive Committee of the World Power Conference with the recommendation that the more practical suggestion of the two should be followed.

Railway Electrification Sessions

At the two sessions on railway electrification one conclusion stood out forcibly, both in the reports and in their discussion; namely, that the time for competition between the different systems of electric traction has passed, and discussion as to their relative advantages is not only futile, but dangerous to the future of electrification. All the systems tried out to date have been brought up to a state of practical success, and each can be used with great advantage as a substitute for steam traction. Any attempt to split hairs between the different systems simply retards the decision of the steam roads to electrify. What is needed now is the compilation of concrete operating results secured on all electrified systems, in such form as to convince the railroads that the time to electrify is now. This is similar to the opinion held by many in the United States.

[*A report on the final sessions will appear in a later issue.*—Editor.]

THE CUSTOM STILL PERSISTS, in many plants where both heat and power are furnished, of dividing the total weight of coal burned by the total number of kilowatt-hours produced to get the "coal per kilowatt-hour." The figure so obtained is as meaningless as it is easy to figure. The only "coal per kilowatt-hour" that means anything in such plants is that figured from the weight of fuel burned in excess of what would have been required for heating alone.

Why Is the Flue Gas Cooler When the CO_2 Is Higher?

When the percentage of CO_2 is raised, the furnace temperature goes up, because there is less dilution by excess air, and therefore less material to be heated by combustion. Curiously enough, however, such conditions are usually accompanied by a lower temperature at the damper. If this reduced quantity of gas is discharged at a lower temperature than prevailed when more gas was being discharged, it follows that the flue-gas loss is reduced, both through reduction in the mass of gas and through reduction in its final temperature. In other words, something has happened to increase the quantity of heat usefully applied. This paradoxical situation of cooler flue gas with higher furnace temperatures is explained by a consideration of the means by which heat is transmitted.

In the first place the temperature of the incandescent fuel bed increases as the air supply is reduced, and the transmission of heat by radiation directly from the fire to the boiler is greatly increased, since radiation increases rapidly as temperature rises. Accordingly, a decreasing proportion of the heat liberated by combustion is carried from the furnace by hot gas.

Furthermore, recent laboratory investigations have indicated that gases themselves also transfer heat by radiation when the gas temperature is high. The only gases lacking the power to radiate heat are oxygen and nitrogen. As the proportion of these gases decreases, the ability of the mixture to radiate heat increases rapidly, first, because a decrease in these gases is accompanied by a higher temperature and, secondly, because the gases having power to radiate heat are less diluted by gases lacking that power. Accordingly, as the excess air is reduced and the furnace temperature rises, there is an increase of heat transfer due to this gas radiation.

Even though these increased radiation effects may be insufficient to reduce below normal the temperature of the gases entering the boiler tubes, the exit temperature will be generally lower. This is due primarily to the reduced weight of gases involved, which results in a reduced gas velocity in the nest of tubes. This reduced velocity tends to reduce the amount of heat transfer per square foot; however, the fact that the weight of gases flowing is less means that, even with a reduced heat transfer per square foot, the drop in temperature of the gases may be increased.

Studies in the performance of air preheaters seem to indicate what appears to be a slightly different situation. The introduction of preheated air increases the initial temperature of gas leaving the furnace as in the case just considered, but seems also to result in an increased temperature at the boiler exit. In this case the excess air and CO_2 are unchanged. While radiation from the fuel bed and from the gas stream increases with the increased initial temperature, the dilution of radiating gas with non-radiating gas is unaltered, and as a result the gas radiation is not as great as if the CO_2 were increased.

Also there is little reduction in the weight of gases when using preheated air and hence the velocity of the flue gas passing through the nest of tubes is unchanged. The heat transferred from each pound of gas by conduction is, thus, not greatly different and if the gases enter at a higher than normal temperature, they leave likewise at a higher than normal temperature.

How To Lay Out Power-Plant Piping—VII*

By SABIN CROCKER
Designing Engineer, Drafting and Surveying Bureau, The Detroit Edison Company

PRACTICAL application is made easy by a table showing type and thickness of covering for various cases. A sample table shows how to do it.

SO MUCH has been written on the subject of heat insulation[1] that it seems unnecessary to discuss the principles underlying the selection of such material or the methods of applying it.

In picking a covering for high-temperature steam lines, it should be remembered that magnesia and similar substances calcine and powder at temperatures often attained by superheated steam lines. Accordingly, high-temperature steam lines should be insulated next to the pipe with a material that is not only a poor conductor of heat, but also can stand the temperature there without breaking down. The outer layers of covering are not exposed to such high temperature and can safely be made of 85 per cent magnesia or other good insulating material which would not develop a satisfactory life at the high temperature close to the pipe.

It is well worth an economic study for any set of steam or water temperatures to determine what thickness of covering pays the largest return on investment, taking into account the fuel cost corresponding to the heat loss. It is then desirable to incorporate the results of this study in a standard sheet or table in which the proper thickness and kind of covering is set down opposite the different pipe sizes used under each class of service. Such a table worked out for the conditions in the Detroit Edison Company's plants is given below, but it is not safe to assume that this will apply in general. The matter must be studied for each individual situation if best results are desired.

Attention is directed to the covering of cold water pipes to prevent freezing or sweating. Freezing can produce serious damage, and sweating, with the resulting dripping, is, to say the least, objectionable, and it may be the cause of serious damage, as, for example, in the case of electrical machinery.

*Part I in *Power* for May 18, 1926; Part II, June 8; Part III, June 22; Part IV, July 6; Part V, August 3; Part VI, Sept. 14. The present article concludes the series.

[1]See, for example, "The Rational Design of Covering for Pipes Carrying Steam up to 800 Degrees F.," by W. A. Carter and E. T. Cope, Transactions A.S.M.E. 1925, and "Choosing Economical Thickness of Heat Insulation," by L. E. Whitaker, *Power*, May 18, 1926, p. 762.

A TYPICAL TABLE OF PIPE COVERING STANDARDS FOR VARIOUS SERVICES

NORMAL PIPE SIZE	THICKNESS STD	THICKNESS STANDARD WEIGHT EXTRA STRONG DOUBLE EXTRA STRONG		TEMPERATURE OF THE FLUID IN THE PIPE 650° F TO 800° F: THICKNESS OF FIRE BACKING	650° F TO 800° F: THICKNESS OF 85% MAGNESIA	500° F TO 650° F: THICKNESS OF FIRE BACKING *	500° F TO 650° F: THICKNESS OF 85% MAGNESIA	300° F TO 500° F	100° F TO 300° F	ICE MEN SKIN AND CITY MAINS	DRINKING WATER	NOTES
1	7/8	3/4 1/4	STRAIGHT PIPE & BENDS	2" SECTIONAL 6 OZ SHEETING COVERED	NONE	2" SECTIONAL SHEETING COVERED	NONE	DOUBLE LAYER DOUBLE STANDARD 85% MAGNESIA SECTIONAL COVERING (PIPES AND BENDS) UP TO AND INCLUDING 8" PIPE-SEGMENTAL BLOCK ON PIPE AND LARGER		SINGLE PLY TAR PAPER-TWO-INCH LAYERS HAIR FELT FASTENED WITH FOUR PLY JUTE TWINE AND TAR PAPER 6 OZ SHEETING SEWED ON AND PAINTED OUTDOORS-BANDS EVERY 3FT.	ANTI-FREEZE	
			FITTINGS FLANGES ETC	2" SECTIONAL 6 OZ SHEETING COVERED	NONE	2" SECTIONAL SHEETING COVERED	NONE					
1 1/4	7/8	3/4 1/4	STRAIGHT PIPE & BENDS	2" SECTIONAL SHEETING COVERED	NONE	2" SECTIONAL SHEETING COVERED	NONE			ONE INCH THK LINED WOOL FELT COVERING, 6 OZ SHEETING PASTED ON AND FASTENED WITH 3/4" x 1" STAPLES PAINTED OUTSIDE. HAIR FELT AND 6 OZ SHEETING FOR FITTINGS, ETC.	ANTI-SWEAT	
			FITTINGS FLANGES ETC	2" SECTIONAL SHEETING COVERED	NONE	2" SECTIONAL SHEETING COVERED	NONE					
1 1/2	7/8	3/4 1/4	STRAIGHT PIPE & BENDS	2" SECTIONAL SHEETING COVERED	NONE	2" SECTIONAL SHEETING COVERED	NONE					
			FITTINGS FLANGES ETC	1"x 3" x 36" BLOCK	1"x 3"x 36" BLOCK	1"x 3"x 36" BLOCK	1"x 3"x 36" BLOCK					
2	1 1/32	2 1/16	STRAIGHT PIPE & BENDS	1 1/32" SECTIONAL	4" SECTIONAL COVERING 1 1/2" THICK	1 1/32" SECTIONAL	4" SECTIONAL COVERING 1 1/2" THICK			1/2" SECTIONAL SHEETING COVERED	GALVANIZED SOFT STEEL WIRE 6 OZ SHEETING AND GLUE COMES WITH COVERING	NOTE A:- EACH LAYER OF ALL TWO LAYER BLOCK COVERINGS IS TO BE TIED ON WITH GALVANIZED WIRE 16 GAGE ON PIPES OVER 10 INCH (8 GAGE ON 12 INCH & UNDER. THE OUTSIDE LAYER ON PIPE 6 IN AND LARGER IS TO BE LACED WITH 14 IN OF 5/8 CONKLINS #00 ASBESTOS CEMENT FINISHED SMOOTH AND WRAPPED 6 OZ SHEETING PASTED ON ALL COVERING TO BE WRAPPED WITH 6 OZ SHEETING PASTED ON EXCEPT AS NOTED
NOTE B:- FLAT BLOCKS ARE KNOWN AS "JOHN-MANVILLE FULL BACKING."
NOTE C:- SECTIONAL FORM AS "JOHN MANVILLE HIGH TEMPERATURE INSULATION"
			FITTINGS FLANGES ETC	1" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK	1" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK					
3	1 1/32	2 1/16	STRAIGHT PIPE & BENDS	1 1/32" SECTIONAL	5" SECTIONAL COVERING 1 1/2" THICK	1 1/32" SECTIONAL	5" SECTIONAL COVERING 1 1/2" THICK					
			FITTINGS FLANGES ETC	1" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK	1" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK					
4	1 1/8	2 1/4	STRAIGHT PIPE & BENDS	1 1/8" SECTIONAL	6" SECTIONAL COVERING 1 1/2" THICK	1 1/8" SECTIONAL	6" SECTIONAL COVERING 1 1/2" THICK					
			FITTINGS FLANGES ETC	1" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK	1" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK					
6	1 1/8	2 1/4	STRAIGHT PIPE & BENDS	1 1/2" SECTIONAL	1 1/2" SEGMENTAL BLOCK TO COVER 1 1/2" COVERING ON 6" PIPE	1 1/2" SECTIONAL	1 1/2" SEGMENTAL BLOCK TO COVER 1 1/2" COVERING ON 6" PIPE					
			FITTINGS FLANGES ETC	1 1/2" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK					
8	1 1/4	2 1/2	STRAIGHT PIPE & BENDS	1 1/4" SECTIONAL	2" SEGMENTAL BLOCK TO COVER 1 1/2" COVERING ON 8" PIPE	1 1/2" SECTIONAL	1 1/2" SEGMENTAL BLOCK TO COVER 1 1/2" COVERING ON 8" PIPE					
			FITTINGS FLANGES ETC	1 1/2" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK					
10	1 1/4	2 1/2	STRAIGHT PIPE	1 1/2" SEGMENTAL	2" SEGMENTAL BLOCK TO COVER 1 1/2" COVERING ON 10" PIPE	1 1/2" SEGMENTAL	1 1/2" SEGMENTAL BLOCK TO COVER 1 1/2" COVERING ON 10" PIPE					
			BENDS, FITTINGS FLANGES ETC	1 1/2" x 3" x 36" BLOCK	2" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK					
12	1 1/2	3	STRAIGHT PIPE	1 1/2" SEGMENTAL	2" SEGMENTAL BLOCK TO COVER 1 1/2" COVERING ON 12" PIPE	1 1/2" SEGMENTAL	1 1/2" SEGMENTAL BLOCK TO COVER 1 1/2" COVERING ON 12" PIPE					
			BENDS, FITTINGS FLANGES ETC	1 1/2" x 3" x 36" BLOCK	2" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK					
14	1 1/2	3	STRAIGHT PIPE	2" SEGMENTAL	1 1/2" SEGMENTAL BLOCK TO COVER 2" COVERING ON 14" PIPE	1 1/2" SEGMENTAL	1 1/2" SEGMENTAL BLOCK TO COVER 1 1/2" COVERING ON 14" PIPE					
			BENDS, FITTINGS FLANGES ETC	1 1/2" x 3" x 36" BLOCK	2" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK					
16	1 1/2	3	STRAIGHT PIPE	2" SEGMENTAL	2" SEGMENTAL BLOCK TO COVER 2" COVERING ON 16" PIPE	1 1/2" SEGMENTAL	1 1/2" SEGMENTAL BLOCK TO COVER 1 1/2" COVERING ON 16" PIPE					
			BENDS, FITTINGS FLANGES ETC	2" x 3" x 36" BLOCK	2" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK	1 1/2" x 3" x 36" BLOCK					

Larger Solid-Injection Diesels of the Port-Scavenging Type

FAIRBANKS-MORSE & CO. are now building two-stroke cycle, single-acting, port-scavenging, airless-injection Diesels in 480- 600- and 720-hp. sizes. Features are two-stage combustion, pressure lubrication throughout, reversible and centralized control and a built-in scavenging pump.

RECENT announcement has been made by Fairbanks-Morse & Co. of a larger line of Diesel engines in ratings of 480, 600 and 720 hp. These new engines are of the two-stroke cycle, single-acting, port-scavenging, airless-injection type, incorporating a number of features, such as two-stage combustion, pressure lubrication throughout, reversible and centralized control and a built-in scavenging pump. Although compact, the engines have been designed for accessibility, hard service with minimum operating attention and high fuel economy.

As airless injection of fuel and two-stage combustion had proved effective in the smaller engines, the same principle was used in the new design. In this system the fuel is sprayed into a combustion chamber at the top of the cylinder. The timing of the injection is such that the flow of air from the cylinder up through the neck of the combustion-chamber space meets the injected fuel, causing considerable turbulence and an intimate mixture of the fuel and the air.

This mingling of air and fuel takes place just at the instant of the maximum compression of 500 lb. As the temperature at this compression is 1,000 deg. F. or more, the fuel charge ignites and slow combustion begins. With insufficient oxygen in the chamber for complete combustion a part of the fuel charge burns to carbon monoxide. As the piston recedes on the downward stroke, the gases flow through the neck into the cylinder space, where the cylinder air mixes with the CO gas and remaining oil vapor and the final combustion of the charge to carbon dioxide gas is completed.

A rotary pump draws the lubricating oil from a main storage tank and forces it through a duplex strainer and a cooler into the header shown in the lower base of the engine, Figs. 1 and 2. The oil enters the header under pressure and is distributed by branch lines to all main bearings and through the drilled shaft and connecting rods to the crankpins and piston pins.

A tube from the piston pin connects with the cooling space in the piston head, the oil leaving by a telescopic pipe from this space to an oil pocket in the upper base of the engine. From this point the oil, after passing through a thermometer well on the outside of the upper base, discharges into the lower base, and finally flows into the main storage tank to repeat the cycle.

As will be seen in Fig. 1, each of the cylinders is lubricated at three points by a forced-feed lubricator.

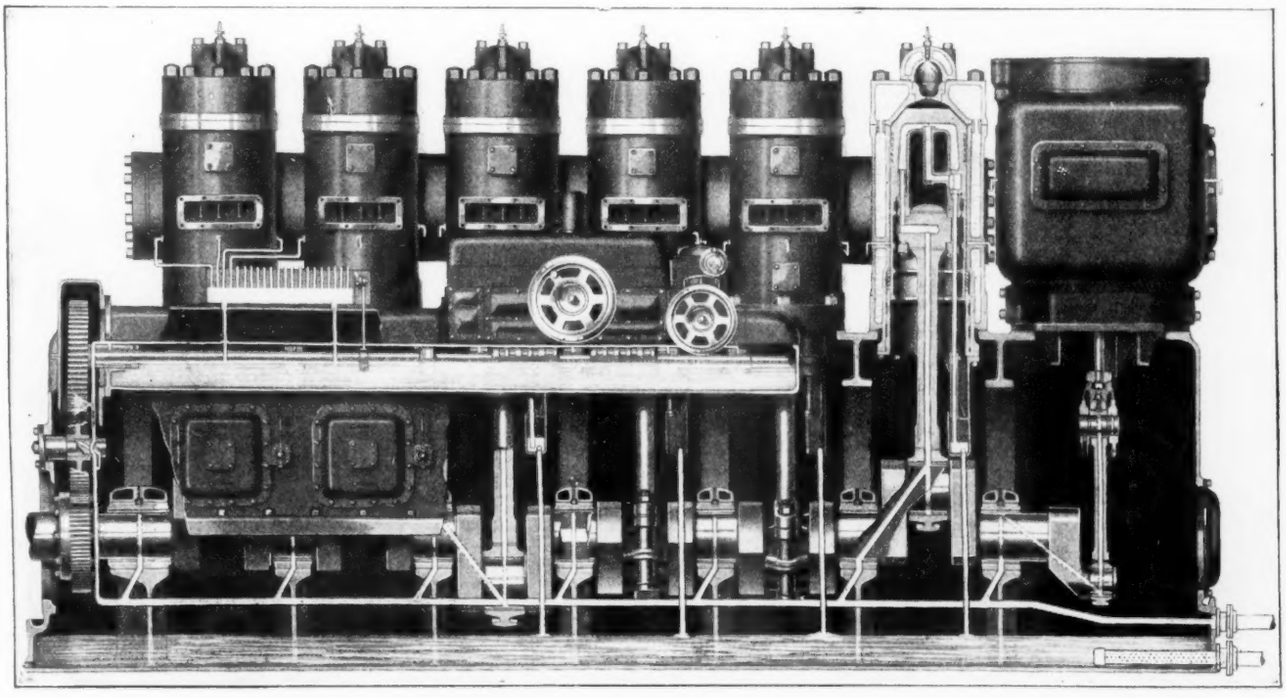


Fig. 1—Large Fairbanks-Morse Diesel in part section

A feature of the cylinder lubrication is the use of four wiper rings, set in the lower recessed part of each cylinder that has been bored out to a greater diameter than the piston, and held in place by a sleeve bolted to the bottom of the cylinder. The construction is such that the upper and the lower edge of each ring make a wiping contact with the piston. The oil wiped off is drained first to a small pocket in the ring itself and thence through holes drilled at an angle at twelve points

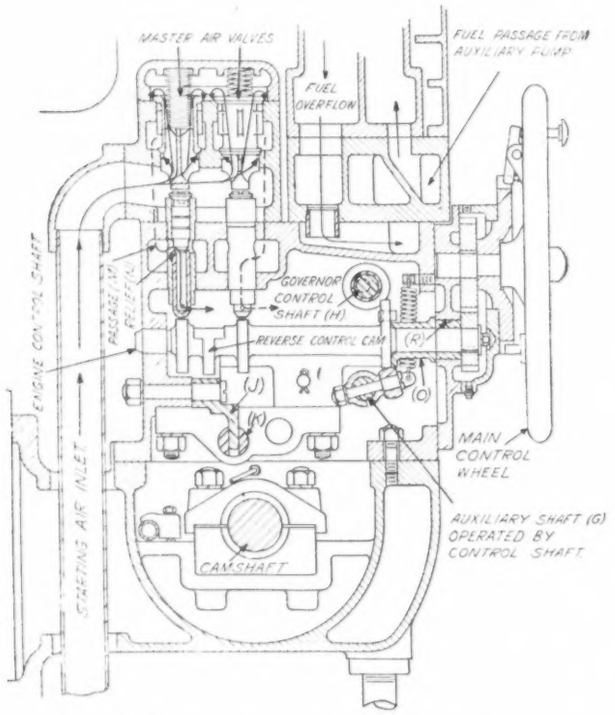


Fig. 2—Section through control unit showing starting and reversing mechanism

around the circumference of the ring into a space behind the sleeve holding the rings in place. A small pipe header takes this oil to a sump from which it passes through the purification system.

Centralized Control of the Engine

Control of the engine is centered in a compact and accessible unit, located at the center of the engine, which houses the injection pumps and air starting mechanism. The accompanying sectional views, Figs. 3 and 4, show the general arrangement.

In starting the engine, the first step is to throw the control handwheel to the starting position. Through reduction gears the handwheel turns the engine control shaft on which are two cams for actuating two double-seated master air valves. One of the valves connects with the passageway supplying starting air to the individual valves for the three forward cylinders, and the other valve supplies air to the valves for the three after cylinders. These individual valves are cam-operated, so that the air is admitted to each cylinder at the proper time in the stroke for the desired direction of rotation. When the valves are open, the flow of air is as indicated by the arrows in Fig. 2.

At the time of the opening of the master air valve, a cam on the engine control shaft rotates an auxiliary shaft connected by a link to the governor control shaft. Rotating in eccentric bearings, this governor control shaft regulates the angular position of the suction valve rockers, which in turn control the opening of the fuel suction valves.

As soon as the engine is turned over on compressed air, the handwheel is turned back to the second starting position. One of the cams on the engine control shaft allows one of the master valves to close off the compressed-air supply from three of the cylinders, and fuel oil is injected to these cylinders. The handwheel is then turned to the run position, closing the other master air valve, thereby cutting off the compressed air from the remainder of the cylinders and firing becomes regular in all cylinders.

As soon as the master air valves are closed, the air pressure in the passages supplying the individual valves forces down the lower push rods of the air starting valves, thus allowing the air in passage *M* to bleed out to atmosphere between the upper and lower push rods through the holes indicated by the arrows. The air pressure above the individual valves is thus relieved, and the springs lift up the air start rockers until they

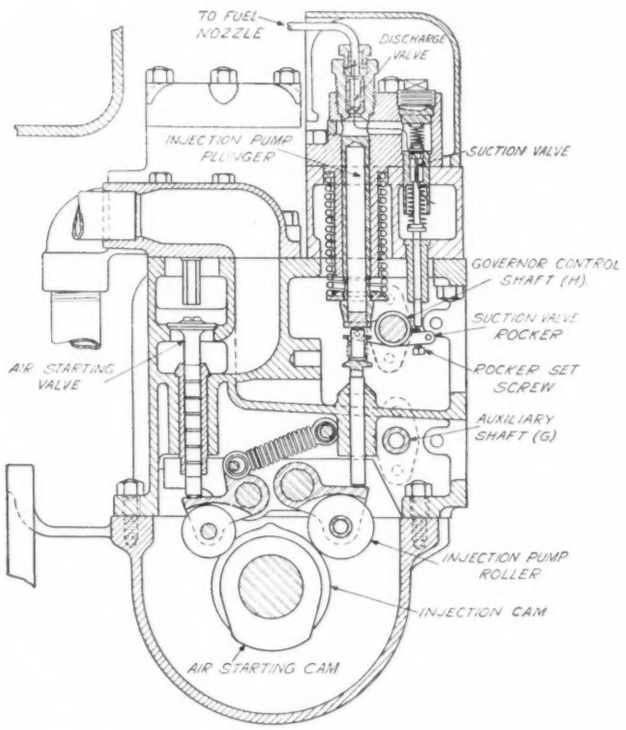


Fig. 3—Section through injection pump assembly

strike the stop. The rockers and rollers from the individual valves to the cylinders are therefore clear of the air starting cams except during the starting operation.

Fuel-Injection Pumps

It will be noticed that the camshaft also carries the cams for operating the fuel injection pumps. As the cam revolves, it raises the injection pump roller, which in turn actuates the injection pump plunger. It is not possible, however, for fuel to be injected through the discharge valve to the cylinder until the suction valve has closed. The closing of the suction valve is accomplished by a valve rocker actuated by the upward movement of the injection pump plunger. This rocker is pivoted on a shaft and is turned through a slight angle

as the pump plunger moves upward. As the rocker drops, the suction valve closes and the fuel oil is trapped so that its only course is through the discharge valve to the cylinder. The suction valve rocker is pivoted in eccentric bearings, and the time at which the suction valve closes is determined by the position of the governor weights linked with this shaft. Each cylinder has its own injection pump unit, which is bolted to the common pump housing.

A large range of speed variation can be obtained by turning the speed-control wheel. A reduction of speed is obtained by putting tension on the speed-control spring, Fig. 4, which in turn pulls down the arm to which it is pivoted and thus counteracts the main governor spring.

In marine service, where it is necessary to vary the speed of the engine through a wide range, it may be necessary to change the speed of the engine more

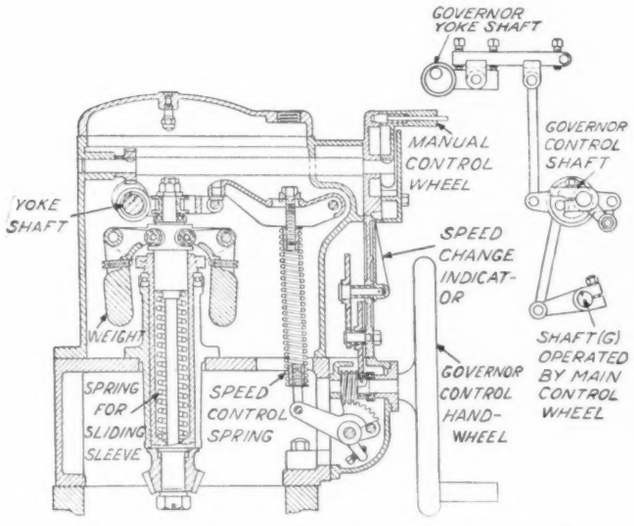


Fig. 4—Flyball governor and linkage assembly to control shaft

rapidly than is possible with the governor control handwheel. This is accomplished by the addition of a manual control device, shown in Fig. 4 to consist of a handwheel that operates the governor yoke shaft and thus the governor linkage controlling the suction valve.

Oil to the suction of the injection pumps is supplied by an auxiliary fuel pump driven by an eccentric from the camshaft. This auxiliary pump is located at the end of the injection pump housing. A link motion and crosshead are used to reduce the wear on the plunger to a minimum. A removable strainer in the casting prevents passing on any impurities to the injection pumps.

The piston construction is unusual in that it consists of an outer shell into which is placed a central casting carrying the piston-pin bearing bosses. This casting forms the inner wall of the oil cooling cavity and transmits the cylinder pressure from the piston to the connecting rod and may be removed for inspection without difficulty.

The double-acting scavenging pump, which is built in as a part of the engine, has a cylinder diameter of 31 in. The capacity is sufficient so that the air pressure is maintained practically constant in the scavenging air manifold. This pressure is about 2½ pounds. Light plate valves of the automobile type are used.

Insulation Paid 300 Per Cent in a Refrigerating Plant

By C. T. Baker

Operation costs in refrigeration plants are often high simply because the engineer fails to appreciate the accumulative effects of a large number of small losses.

An investigation of the fuel consumption in a large distilled-water ice plant disclosed the fact that more fuel was being used per ton of ice than was necessary. As fuel was unduly expensive, it was apparent that any change that would reduce its consumption would be justified and would pay a good return in lower operating costs, provided, of course, that the costs of such changes were not excessive.

Among other things the reboiler, which was a rectangular tank fitted with steam coils, was carefully gone over and it was found that the amount of live steam consumed in reboiling the water was excessive.

As the reboiler was not insulated, the first move was to build a wooden form around its sides and ends, allowing a space of 12 in. between the inner edge of the form and the walls of the reboiler. The reboiler was then raised about 5 in. in order to permit the placing of a 4-in. sheet of cork underneath.

After being lowered back in position and the steam connections reconnected, the space between the walls and wooden form was filled with dry planer shavings, thus providing complete insulation for all exposed surfaces. The top was then refitted and arranged to prevent water leaking into the insulation.

Steam was supplied to the coils at a boiler pressure of 125 lb. through a 1¼-in. steam line. In operation the valve on this line near the coil inlet was opened wide and the valve at the coil outlet was opened enough to keep the coil free of condensation, usually about one to one and a half full turns. This adjustment was more or less guesswork and required considerable alteration from time to time.

An unused steam trap was discovered in the storeroom. This was put in condition and connected to the outlet connection of the steam coil with the trap discharge connected to the open feed-water heater into which a few steam pumps exhausted, but did not furnish sufficient heat to bring the feed water to a suitable temperature.

It was found also that much unnecessary boiling occurred at times when the ice pull was irregular. By placing an automatic temperature control valve on the steam-inlet line to the coil, the steam automatically cut off when the temperature of the distilled water reached the boiling point and, of course, opened again at a predetermined slightly lower temperature.

By this arrangement a practically constant temperature was maintained in the reboiler and the amount of steam admitted to the coil was dependent upon the amount and temperature of the condensate being delivered to the reboiler.

The total cost of these improvements was $170 and the resulting fuel saving, which was carefully checked before any further changes were made, was found to be $1.50 per day of 24 hours.

In the Usual Analysis of flue gas the sulphur dioxide that may be present when the Orsat is reached, is absorbed with the carbon dioxide through the agency of the caustic potash.

Routine Inspection Procedure for Power-Station Equipment

By C. R. REID
Power House Superintendent, Shawinigan Water & Power Company

THE great amount and variety of apparatus in a large generating station makes it desirable to systematize the work of inspection, in order that it will be regular and complete. Although the methods of inspection and record keeping described in this article are for large hydro-electric stations, they can be used as the basis for working up a systematized inspection schedule for almost any size or type of plant.

IN THE larger power houses of the Shawwinigan Water & Power Co., Shawinigan Falls, Quebec, the operating staff consists of a shift operator who is in charge of the station on his shift, a control operator, and one or more floormen and wheelmen as required. The shift operator and control operator are located in the control room of the power house, and only one of them leaves the control room at a time so that one is always on duty there. The shift operator makes the inspections. There are three of these for each station, working 8-hour shifts, thus covering the 24 hours of the day. Each of these shift operators is assigned certain specified units of the station apparatus for regular inspection and is held responsible for the condition of these units.

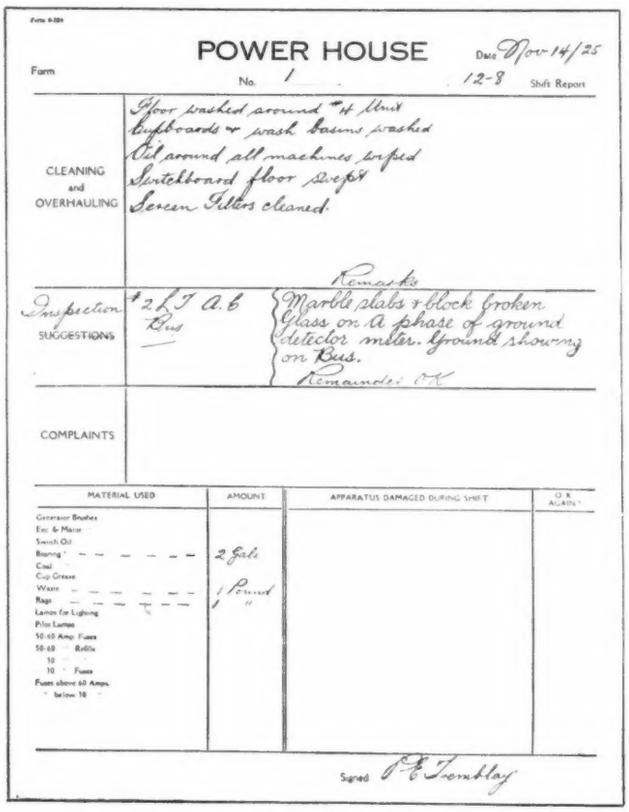
From the foregoing it will be seen that the inspection is made by the man that is usually known as the chief operator. This man has other duties which take him out of the control room. For instance, he personally supervises the operation of manually operated switches in the power house. When any piece of apparatus is giving trouble, he supervises the efforts made by his assistants to restore it to working condition. Inspection covers the items enumerated in the following instructions, which are issued to the operators:

"Operator's inspection shall consist of examining apparatus outwardly, and judging by certain visible, audible and other signs, whether apparatus is O. K. or not. Where it becomes necessary to dismantle apparatus to make an inspection, involving work of some magnitude, such work will be done by the maintenance department. However, experience has proved that certain troubles can be caught before actual breakdowns, manifesting themselves by various symptoms, such as heat, noise, cracks, change in color, leaks, unusual meter readings, and various other signs. By a systematic inspection it is hoped we can catch the symptoms and make a decided saving in repair bills.

"When certain parts of apparatus are found to be out of order, the entries on the inspection sheet of such parts should be written in red ink, and a station-trouble report made out to cover same. The red ink will indicate that a report covering trouble has been made out. It will not be necessary to make out more than one trouble report for the same fault, but should the apparatus still be faulty when the next inspection is made, its entry is to be again written in red ink and continued this way until it has been remedied.

"Inspections are to be arranged so that all apparatus is covered at least once in three weeks under normal operation. Advantage must be taken of shutdowns to inspect normally inaccessible parts. When conditions permit, apparatus may be shut down for cleaning and inspection after 7 p.m., due inquiry being made of system operator as to load prospects, etc.

"No voltage higher than 220 volts is to be handled, and even this will be touched only when insulated from ground, and from opposite pole of line or switch. When handling live stuff, use only one hand and no tools, as far as possible.



POWER HOUSE

Form No. 1 Date Nov 14/25

12-8 Shift Report

CLEANING and OVERHAULING: Floor washed around #4 Unit; Cupboards & wash basins washed; Oil around all machines wiped; Switchboard floor swept; Screen Filters cleaned.

Remarks

Inspection SUGGESTIONS: #2 L I A.B Bus — Marble slabs & block broken; Glass on A phase of ground detector meter. Ground showing on Bus. Remainder OK

COMPLAINTS

MATERIAL USED	AMOUNT	APPARATUS DAMAGED DURING SHIFT	O. K. AGAIN?
Generator Brushes			
Exc. & Motor			
Switch Oil			
Bearing "	2 Gals		
Coal			
Cup Grease			
Waste	1 Pound		
Rags	1 "		
Lamps for Lighting			
Pilot Lamps			
50-60 Amp. Fuses			
50-60 " Refills			
10 " "			
10 " Fuses			
Fuses above 60 Amps.			
" below 10 "			

Signed F. E. Tremblay

Fig. 1—Operator's inspection report form

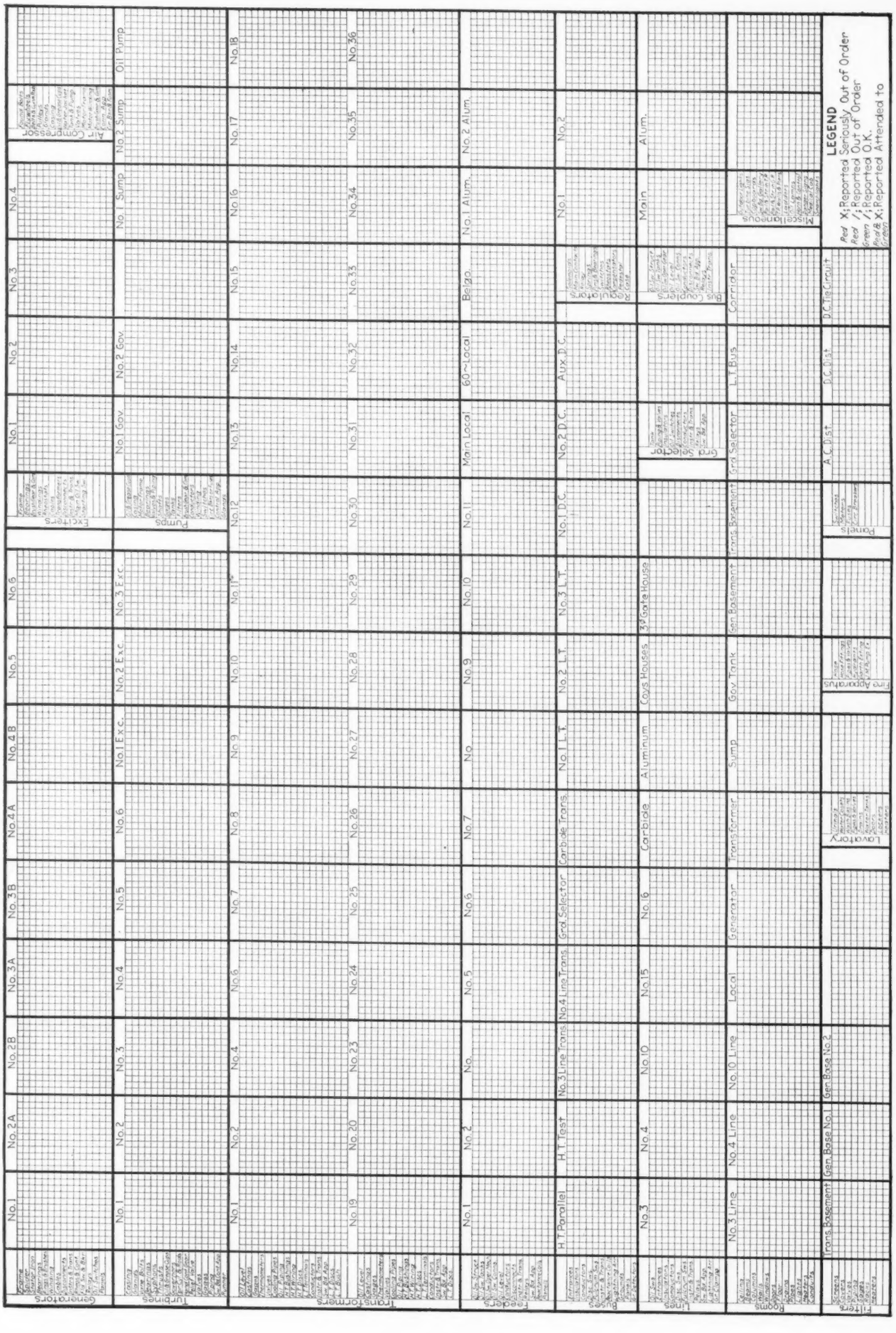


Fig. 2—Chart on which the condition of all the equipment in the plant is recorded

"Among the various things to be noted are the following:

Lead-covered cables showing cracks, or holes in lead.
Disconnecting switches turning blue.
Nuts loose.
Cables slack in cleats.
Cracks in brickwork.
Ground wires on lead of cables loose, causing sparks.
Pipes leaking and showing corrosion.
Valve stems bent.
Valve wheels loose or missing.
Oil or grease cups empty or missing.
Transformer terminals blue or smoking.
Transformer cooling pipes blocked.
Transformer piping, water or oil, leaking.
Transformer case dirty.
Racks and platforms rickety due to vibration or lack of support.
Railings loose or missing.
Conduit clamps pulled away from walls.
Conduits loose.
Water or oil dripping on conduits.
Ladders broken; rungs missing.
Generator end connectors showing signs of heating.
Unusual vibration of machinery.

"A few items per day should be taken and thoroughly inspected, not merely glanced at."

The operator's inspection list for No. 2 power house is given in the following:

Exciters: Frame; brush gear; commutator; cables; knife switches; instruments; main field rheostat; auxiliary field rheostat; circuit-breaker; panel wiring; bearings; motor; starting switch; oil switch.

Regulators: Solenoids; floating contact; springs; relay contact; switches; compensators; dashpot; h.-v. relay; circuit-breakers; case.

Generators: Frame; windings; cables; l.-t. disconnects; No. 1 l.-t. oil switch; instrument transformer; pedestal instruments; recording instruments; bench-board control apparatus; panel; wiring; field breaker and knife switch; field-rheostat dial plate and motor; field rheostat; slip rings and brush gear; field spider, including fan blades, etc.; balance relays; bearings; stator iron.

Main and Exciter Turbines: Casing; bearings; engine; relief valve; stuffing boxes; vane links; grease and oil cups; governor piping; valves; bearing oil and water piping; governor; governor belts; governor control motor; gages; indicators; signals; bursting plates; hand-control mechanism; brake; receiver tank.

Pumps: Casing; bearings; stuffing boxes; grease and oil cups; main piping; filters; bearing oil and water piping; couplings; gages; indicators; valves; motor casing; brush gear; commutator; windings; starting apparatus; tanks.

Transformers: Casing; l.-t. cables and terminals; h.-t. bushings and terminals; cooling pipes; h.-t. disconnects; l.-t. disconnects; h.-t. oil switch; l.-t. oil switch; h.-t. oil switch and disconnect-switch signals; l.-t. oil switch and disconnect-switch signals; h.-t. switch room; h.-t. wiring; gages; thermometers; indicators; valves; piping; instruments; switchboard control apparatus; ground neutral connections.

Lines: Entrance bushings; oil switches; instruments; disconnect switches; oil switch and disconnect-switch signals; choke coils; lightning arresters; lightning-arrester gaps; rooms; insulators; switchboard control apparatus; h.-t. wiring.

Busses: Disconnect switches; disconnect-switch signals; insulators; rooms; cables; instruments; instrument transformer; wiring; busbars; clamps.

Battery and Booster: Plates; electrolyte; cells; busbars; cables; asphaltum painting; recording hydrometer; circuit breakers; switches; instruments; relays; panel wiring; brush gear and commutator; starting apparatus; field rheostat; bearings; gages.

Blowers and Fans: Brush gear and commutator; bearings; starting apparatus; windings; propellers; switches; wiring; circuit breakers or fuses.

Fire Apparatus: Hydrants; hose; hose fittings; sand pails; J. M. pump extinguishers; J. M. powder extinguishers.

Generator Basement: Lights; heaters; oil piping; water piping; tanks; walls; columns; beams; floor; drains; conduits.

Pipe Tunnel: Pipes; valves; ceiling; bulkhead; drains; lights; conduits; walls.

Sump Room and Generator Tunnel: Lights; conduits; walls; drains; bulkheads; doors; l.-t. neutral resistance; sump.

Cellar and Storage Room: Lights; conduits; walls; drains; cables.

Air Compressors: Motor windings; brush gear and commutator; starting apparatus; packing; glands; gages; oil and grease cups; connecting rods; belts and pulleys; foundation; bolts; water jacket; piping; flywheel.

Filters: Screens; covers; valves; piping; gages.

Elevator: Hoisting cables; lubrication; motor; control apparatus; carriage; limit switches; safety switch; safety wire; doors; lights.

Rooms: Floor; windows; columns; beams; walls; ceiling; doors; lights; drains; heaters.

Lavatory: Urinals; w. c.'s; wash basins; showers; hot-water tanks; lockers; lights."

Each operator covers his entire assignment once in each calendar month. In this way twelve complete inspections are made per year. The chief operator endeavors to inspect at least one piece of apparatus on each shift and makes a report on the daily-shift report shown in Fig. 1. These reports are turned in to the superintendent's office and checked off on the chart shown in Fig. 2.

On this chart each of the large spaces referring to any specific piece of equipment is divided into twelve vertical columns, one for each monthly inspection. These vertical columns are divided horizontally in accordance with the item on any piece of apparatus to be inspected. Each daily shift report is recorded in a vertical column on the chart assigned to the equipment, in accordance with the legend shown in the lower right-hand corner. If a part of a piece of equipment is reported seriously out of order, a red $\times$ is put in a small square space to the right of this item. When the work has been done, the red $\times$ is replaced by a green diagonal dash, which is the check mark used when equipment is reported in good condition. Parts of equipment out of order that do not need immediate attention are indicated by a red diagonal dash. When these repairs have been made, another diagonal dash is added to form a red and green $\times$.

This chart has proved to be of great value in keeping

SHAWINIGAN WATER & POWER CO.
SHAWINIGAN FALLS QUE.

Maintenance Inspection Record of 6600 Volt OILSWITCHES
Location #1 Sentol. #2 Generator P. H. #2
Date Sept 14/25

Item	Condition left in	
Operating Mechanism	Dusty Loose bolts & nuts	OK
Magnet Coils	OK	OK
Pilot Switch	OK	OK
Indicating Lights	OK	OK
Controller	OK	OK
Current Transformers	OK	OK
Tanks	OK	OK
Gauge Glasses	OK	OK
Mufflers & Vents	OK	OK
Stops & Buffers	OK	OK
Valves	OK	OK
Terminal Bushings	OK	OK
Main Contacts	Centre & Right Main Switch Contacts old burned	OK
Resistance Contacts	Burnt - refaced	OK
Arcing Contacts	Burnt. refaced	OK
Rods & Crossbars	OK	OK
Porcelain Shields & Bushings	Bushing Clamp loose	OK
Oil Level	Low - some added	OK
Condition of Oil	OK	OK
Oil Breakdown Voltage	36 KV	36 KV
Was Oil Filtered?	No	
Is Relay Trip O. K.		
Inspected by	W H Turner	

Remarks over SIGNED W A Scott
Foreman

Fig. 3—Maintenance inspection record for oil switches

SHAWINIGAN WATER & POWER CO.
SHAWINIGAN FALLS QUE.

Maintenance Inspection Record of STANDARD UNITS
Transformer No. 4 Location #4 Tunnel P.H. #1
Date Oct 22 1925

Item		Condition left in
H. T. Bushings	OK	OK
L. T. Bushings	OK	OK
L. T. Cables	OK	OK
L. T. Insulators & Cleats	OK	OK
H. T. Discs. & Signals	OK	OK
L. T. Discs.	OK	OK
Valves	OK	OK
Thermometer	OK	OK
Oil Level	OK	OK
Oil Test	Tested to 36000 V	OK
Cable Ground Clamps	OK	OK
H. T. Megger Test	500	OK
L. T. Megger Test	40	OK
H. T. to L. T. Megger Test	175	OK
Diaphragms	—	—
Breathers	—	—
Manhole Covers	OK	OK
Cooling Coils	OK	OK
Was Oil Dropped	Yes	—
Inspected by	L M. Williams	

Remarks Over SIGNED W A Scott
Foreman

Fig. 4—Maintenance inspection record for transformers

SHAWINIGAN WATER & POWER CO.
SHAWINIGAN FALLS QUE

Maintenance Inspection Record of GENERATORS
Generator No. 3 Location P. H. #2
Date Nov 15 1925

Item		Condition left in
Armature Clamping Bolts	OK	OK
Rotor Clamping Bolts	OK	OK
Armature Winding Test	OK	3000 V / Minute OK
Armature Cording	OK	OK
Armature End Connectors	OK	OK
Field Winding Test	OK	1500 V / Minute OK
Field Cording	OK	OK
Slip Rings	OK	OK
Brushgear	OK	OK
Bearing Oil	OK	OK
Oil Rings	OK	OK
Fan Blades	OK	OK
Terminals	OK	OK
Cables	OK	OK
Cables Test	OK	5000 V / Minute OK
Field Breaker & Signals	OK	OK
Field Rheostat	OK	OK
Field Rheostat Motor	OK	OK
Relays	OK	OK
Instrument Transformers	OK	OK
Cable Ground Clamps	OK	OK
Was Relay Trip Tried:	OK	Yes - OK
Disc. Switches	OK	
Inspected By	A Racine	

Remarks over SIGNED W A Scott
Foreman

Fig. 5—Maintenance inspection record for generators

SHAWINIGAN WATER & POWER CO.
SHAWINIGAN FALLS QUE

Maintenance Inspection Record of Fan MOTORS
Motor No 35 Location Crew House P. H.
Date Nov 10 1925

Item		Condition left in
Brushgear	OK	OK
Commutator	Slip Rings	OK
Shunt Field Winding	—	—
Series Field Winding	—	—
Armature Winding	OK	OK
Rotor End Connections	OK	OK
Frame	—	—
Armature Spiders	—	—
Armature Bands	—	—
Packer Ring	—	—
Air Cap	OK	OK
Oil Rings	OK	OK
Oil Level	OK	OK
Fans	—	—
Main Switch	OK	OK
Over Current Breaker & Relays	—	—
Starter	OK	OK
No Voltage Release	—	—
Compensator	—	—
Meters	—	—
Fuses	OK	OK
Ground Wires to Frame	—	—
Overall Megger Rig.	Rotor 19 MΩ - Stator 75 MΩ	
Inspected by	F Cameron	

Remarks over SIGNED W A Scott
Foreman

Fig. 6—Maintenance inspection record for motors

track of the inspection work. It is mounted on the office wall, and is large enough (28x38 in.) to provide plenty of space. A glance at the chart will show if the inspections are being properly carried out; also, defective apparatus can readily be noted.

In addition to the regular inspection reports as described, the chief operator makes out at the end of his shift a trouble report on any machine or piece of apparatus that has proved defective during the shift. This trouble report is turned over to the maintenance foreman who is responsible for making the repair. After the apparatus is again in good condition, the foreman enters the fact on the report and returns it to the superintendent's office.

It is apparent that the operator can make only a casual inspection, dealing with the external appearance of transformers, oil switches and other inclosed apparatus. It is necessary to supplement the operator's inspection with a more thorough one carried out by the maintenance staff. This is done once a year or oftener, depending on the type of apparatus.

The four main items covered by the maintenance staff on routine inspection and overhauling are: Oil switches, transformers, generators and motors. Forms are provided which are filled out by the foreman in charge of the inspection and turned in to the superintendent's office, where the information is recorded and kept on file. The forms used in making out reports on these inspections are shown in Figs. 3 to 6. Although it is rather difficult to give comparative figures, we are satisfied that the system of inspection is well worth its cost in time and money.

Power Lines Used To Limit Motor's Starting Current

In an automatically controlled pumping installation, recently placed in operation at the plant of the Kuner Pickle Co., at Brighton, Colorado, the acceleration time of the pumps is increased by voltage drop in the power circuit leading to the driving motors. The pumping equipment consists of two 8x8-in. triplex pumps rated 200 gal. per min. and discharging into an elevated steel tank against a total head of approximately 175 ft. High starting torque, 15-hp., General Electric, squirrel-cage motors with across-the-line starters are used for driving the pumps, which start against full discharge pressure. Either hand or automatic control may be used, and the automatic arrangement includes sequence starting.

In view of the excess starting torque available in the motors the line copper was purposely made smaller than ordinary practice would dictate in order to cause some additional voltage drop in the line during the starting period. In this way the acceleration of the motors was kept within limits that would not impose objectionable strains on the mechanical parts or objectionable pressure rises in the discharge line. Under these conditions the pumps reach full speed in about 1½ sec., and the pressure rise caused by the acceleration of water in the water column is held to approximately 10 lb., as indicated by pressure gages on the pumps. A pressure-relief valve on this discharge line, set at 15 lb. above maximum static head, has not operated since the equipments were put in operation.

By means of three-pole, double-throw switch, control may be transferred from the automatic pressure governor to the standard hand-operated push button, thus permitting operation of the pumps at any time for inspection or adjustment. The pressure governor is installed on the side of the elevated tank itself, about 300 ft. away from the pumps, and the control circuit is extended by means of lead-covered wires inclosed in steel conduit. Thus more accurate control of the water level is obtained, and the necessity for a separate pressure pipe for the operation of the control (as required for the elimination of the discharge-line friction and pump pulsations) is eliminated. The governor is protected from freezing in cold weather by an inclosing case in which two 60-watt lamps are installed as heaters. These lamps, visible from the ground, may be turned on or shut off by a manual switch at the ground level.

As simultaneous starting of both pumps would involve objectionable power demands and serious excess pressures in the water column, sequence starting is important. By means of a definite-time relay, one pump starts immediately after the pressure governor operates and the other 30 sec. later. Either or both pumps may be operated as desired. The pump motor load is metered separately from the other plant load so that the exact costs of the water supply may be ascertained.

It should be noted that across-the-line starters and motors should be used with extreme caution on triplex-pump installations because of excess pressures and consequent mechanical strains involved in rapid acceleration of water discharge lines. The practice of using reduced copper sections in supply lines, being in conflict with established National Electric Code requirements, may lead to objections by inspection services and should, therefore, be undertaken carefully.

Finding the Number of Poles in an Induction Motor

On direct-current motors the polepieces are projections on the inside of the field frame, and therefore the poles in the machine can be counted. In induction motors the winding is distributed in slots in the inner periphery of the stator core, in much the same way that the winding is placed on the armature of a direct-current machine, consequently the number of poles in the machine cannot be readily counted. One way of determining the number of poles is from the nameplate data. There is a fixed relation between the number of poles, the frequency of the circuit and the speed of the motor; that is, the number of poles equals 120 times the frequency in cycles per second, divided by the speed in revolutions per minute. For example, if the frequency is 60 cycles and the speed is 1,150 r.p.m., the number of poles in the motor equals $120 \times 60 \div 1{,}150 = 6$. It will be noted that this does not come out an even number, which is due to the actual full-load speed being somewhat lower than the theoretical.

Where the nameplate data are not available, the number of poles can generally be determined by the spread of the coils in the stator core. Each coil is placed in slots which are a distance apart about equal to the width of the pole. In a four-pole machine the coil spread will be equal to about one-quarter of the inner periphery of the stator core, and in a six-pole machine the spread will be about one-sixth of the periphery. Owing to chording the coils, they will not in general be found to spread full pitch, but will be close enough to check the number of poles.

Dangerous Boiler Settings

THE practice of setting boilers so as to preclude a thorough external inspection has taken toll of many lives and been responsible for much property damage. Another case of this kind has come to light through investigation into the cause of the recent mud-drum fracture at the plant of Rees & Rees, New York, in which three men were scalded to death. External corrosion of the mud drum had reduced the metal to nearly one-quarter the original thickness, but owing to its inaccessibility, the process had progressed undetected by either the insurance or the city inspectors.

In the majority of such cases the owner is under the impression that all the necessary precautions have been taken, and even the inspectors can hardly be blamed for not detecting something which it is impossible to get at; although an experienced and cautious man, scenting danger in such locations, might insist that the brickwork be ripped out for the inspection. The fault rests primarily on those responsible for the installations in the first place, whose better judgment is often limited by space or other local conditions. Happily, such installations are now seldom made, but there are enough older ones in daily operation to warrant constant vigilance on the part of inspectors and engineers.

International Standardization

THERE are three kinds of standardization that interest the engineer—the standardization of dimensions, the unification of scientific definitions and nomenclature, and the establishment of codes of practice.

In the United States important phases of this work are handled by the American Engineering Standards Committee, whose effective organization is an asset of great value. Similar organizations are at work in many other lands. Now comes a proposal to federate these organizations into an international standards organization, and to this end a constitution has been drafted for consideration by a committee meeting in London this month.

Meanwhile, the International Electrotechnical Commission has been at work for twenty years in the field of electrical engineering. It comprises twenty-eight national committees and has developed invaluable goodwill. In this country the I.E.C. forces have no organic connection with the A.E.S.C., but in Europe such connection exists frequently, and is often very close.

In view of the proposals of the standards organizations it is proposed that the I.E.C. be expanded, with appropriate changes of name and personnel, so as to undertake international negotiations on all matters of technical or engineering interest.

Here is a complex task. An international organization of long standing and high repute has shown its ability to handle effectively certain phases of the task. Other phases are now handled nationally by splendidly organized bodies, in a number of countries, only now reaching out toward international accord.

Shall a new international body be set up, with the inevitable budget and passing of the hat, with a secretariat and ponderous machinery, and with another set of initials to confuse the engineer? Or shall the I.E.C. be expanded to take on the new functions? Can this be done without abandoning much that is best in that body? Can the splendid ability of the A.E.S.C. and its cousins in other lands be wedded to the established international scientific co-operation of the I.E.C. without loss of the essential values of both? Earnest efforts should be directed to this end, for unity adds power to such an undertaking.

Securing a proper solution demands study, and study demands time. It is well that the United States representatives on their way to London go without instructions save to urge the postponement of definite action pending full consideration of all the possibilities.

The promotion of international co-operation in engineering can best be served by going slow.

Heating the Power Plant

LARGE modern power plants have high-pressure piping and other hot parts so well insulated that it is necessary to provide some heating surface to maintain a comfortable working temperature for the operators. The parts often needing such heating are condenser pits, ash basements, coal-crushing rooms, electrical galleries, offices, etc. Plants in the West and North, where severe cold weather is encountered, may need considerable heat. Also these plants must be heated when shut down during off-peak hours and over holidays.

This heating may be furnished by low-pressure steam or by hot water. The former is the method generally adopted and often vacuum systems are installed. The low-pressure steam system is cheaper to install and simple to operate. It may take exhaust steam from a house turbine or from some steam-driven auxiliary and may be supplemented at times by live steam furnished through reducing valves. The system is familiar to operating engineers and generally requires small maintenance.

The hot-water system, though more costly to install, has several operating advantages. The temperature of the water can be regulated to suit weather conditions, whereas the steam system, unless thermostatically or carefully hand controlled, is likely to overheat in mild weather. The water may be heated in various types of heaters with steam from any of several sources. Gland leakage steam, bled steam or the exhaust from auxiliary units may furnish the necessary heat. If the heating load is large, as for instance, when an adjoining factory or other building must be heated, the hot-water system offers distinct advantages. A condenser either of jet or surface type, under the house turbine

or even under one of the main units, may be used to heat this water which is circulated continuously. The vacuum is regulated to provide the proper flow temperatures. The turbine then operates at variable back pressure, which on the whole will be much lower than if it were exhausting into a steam heating system.

The plant is provided with the necessary heating with hot water while the turbine gains the additional power due to its vacuum, which is in line with the principle of the maximum utilization of heat head. The hot-water system of heating by the condenser circulating water is in successful use at the plant of the Ford Motor Co. of Canada. There are undoubtedly other plants that could use it equally well, and these should be studied to determine the economic justification of changing to a hot-water system.

Making Routine Inspections Effective

INSPECTIONS at regular intervals as a means of locating defects in equipment before they cause a shutdown, with the accompanying danger of wrecking the machine, are now generally looked upon as an essential part of good power-plant operation. Unfortunately, these inspections are not always looked after as they should be, especially in the smaller plants. Before any system of inspection can be effective, a regular schedule must be followed by those delegated to make the inspection.

To insure this being done, a follow-up system should be introduced and kept up to date, so that those in authority can easily check up on how the work of inspection is progressing. Such a system should show not only how nearly on schedule the inspections are being made, but also what equipment has been reported defective, how urgent the need of repairs and the progress being made toward completing them.

An inspection system will vary with the type and size of the plant, but the basic idea of all is the same—to provide a means of insuring that the equipment shall receive proper attention. In this issue is described in detail how routine inspections are carried out in a large hydro-electric plant and how the operating superintendent has in his office at all times a complete chart of the inspections made and the condition of the equipment. This system in its precise form may not be applicable to all plants, but it does provide a guide for working up a method suited to the particular conditions in any plant, whether it be water power or steam.

In many cases, after an inspection system has been introduced, other things are allowed to take precedence over the routine inspection, and eventually the system falls into disuse. This can easily happen especially where there are a number of jobs pressing for attention, but these should be an excuse for only minor delays in making the inspections, since lack of attention to some piece of equipment may be the cause of a failure that will not only be expensive, but also take much more time to repair than would have been required to make the inspection and repair before the defect developed into a failure.

The many duties of the chief executive in a power station, combined with the large number of pieces of equipment make it impossible for him to keep in touch with everything unless he has some means of regularly bringing these matters to his attention. An inspection schedule provides a means of delegating to each man in the plant certain equipment for his attention, so that in case of any question on its condition the attendant at fault can be held responsible. When operators know they are definitely responsible for certain work, they will be more careful than when it may be their job today and someone else's tomorrow.

Gaging Turbine Blades

RESEARCH has been valuable in establishing new facts about metals and in providing true explanations for the causes of many failures. This has been particularly beneficial in steam-turbine development. The work of Campbell and others on disk and blade vibration phenomena has been of the greatest value to all users of turbines. These investigators established the fact that not only disks but the blades themselves may be subject to harmonic vibrations. Such vibrations induce stresses in addition to any internal stresses present, the total of which may exceed the fatigue limit of the blading material, in which case failure of the blades will result. Therefore the desirability of eliminating internal stresses in blading will be evident.

The early practice of some builders was to pack the grooves in the spindle as tightly as possible with alternate blades and distance pieces. These were firmly fixed in place by swaging the distance pieces by hammering them with a special tool so that the spread distance piece filled the groove and gripped the blade in place. The swaging often resulted in uneven spacing of blades, which were then twisted to the proper gage by another special tool. This process became known as gaging. End thrust and steam distribution were corrected by gaging.

It is now contended that swaging of the distance pieces and the twisting of the blades in gaging set up internal stresses at the base of the blade. In general, it may be said that any cold working process such as twisting or pressing of the roots of turbine blading is likely to set up undesirable internal stresses. When blade speeds were low, such gaged blades frequently operated for long periods before fatigue failures developed. Increased blade speeds, however, led to early failures of the blades in some cases, and other methods of holding blades were introduced.

Happily, these new methods involving the use of drop-forged blades, often integral with the distance piece and also in cast-in blading, do not set up such internal stresses. Nevertheless, all present-day processes and methods of holding blades in turbine rotors warrant study in order to be sure, if possible, that any internal stresses that may be set up in the material during construction are eliminated.

Consult the Operating Engineers

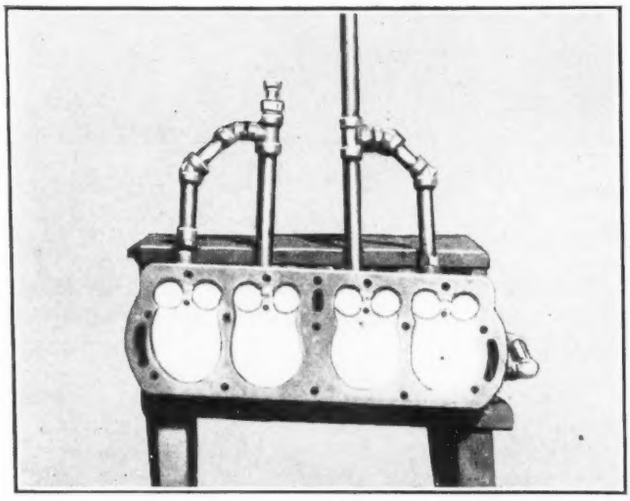
WHEN a large power plant is placed in service, one naturally infers that it is completed or practically so. Unfortunately, as soon as the boilers are fired a process of adjustment usually begins.

The underlying cause of the seemingly never-ending rebuilding in some plants may be traced to lack of co-operation between the office engineers and the operating department. The former are often graduates from the operating field, but since the day they ceased to be operators, plant practice has changed, bringing undreamed-of operating problems. The office engineer cannot appreciate these difficulties and sometimes has not the personal experience necessary to cope with them.

Practical Ideas From Practical Men

How the Engine Was Changed into an Air Compressor

Some time ago we were in need of an air compressor for varnishing windings as well as the usual services at our hydro station. A medium-speed machine suitable for the work was priced at $150. On looking around we secured a second-hand four-cylinder automobile engine in good condition for $10, so we decided to alter it to make an air compressor. It was stripped and cleaned, the cam gear removed, the starting gear turned off the flywheel and the width increased 1¾ in. with wood, and the valve stems were shortened so they



Cylinder head with compression space filled with babbitt

wouldn't ride the cams. As it was necessary to reduce the clearance, the cylinder head was bolted to a pine board and outlined by marking around with a pencil, then removed and the position of the valves located on the board.

A piece of iron pipe was obtained having an external diameter slightly greater than the valves and eight pieces were cut 1¼ in. long. With an expansion bit adjusted to the proper size, holes were bored in the board ½-in. deep where the valves were located and the 1¼-in. length of pipe inserted. The holes were finished through the board the size of the valve stems and the valves were inserted, closing the top of the pipe. Asbestos paper was then laid on the board and fitted around the pipes. Next, four ¼-in. pins were screwed on an angle into each compression space in the head to hold the babbitt. The head was bolted to the board again, warmed with a torch, and about 19 lb. of cheap babbitt poured into the compression space through the spark plug holes. When the head was removed, the compression space was found filled flush with holes cored for the valve lift. The spark plug openings were redrilled and tapped and ½-in. vertical check valves connected by close nipples and piped to the air tank. Cooling water was piped to the water jacket and the compressor was ready. The machine is run at about 120 r.p.m. and gives us plenty of air at 50 to 60 lb. pressure.

Air is taken in through what were intake and exhaust valves with light springs on them and discharged through the ½-in. checks. The cost of altering the engine was small.

Russell, Mass. E. A. SIKES.

Experience With Preheated Air Over the Fire

Pulverized coal has given an impetus to the use of preheated air, its advantages in practice having exceeded theoretical estimates in the improvement of combustion efficiency. In fact, the use of preheated air has extended to the modern small plant, including many stoker installations.

It is the general practice to use the flue gases to preheat the combustion air or to pass it between hollow furnace walls before introducing the air under the grate. While admitting the gain in economy, there are certain factors to be considered which apply more forcibly to the small industrial plant that cannot afford a heavy investment in auxiliary equipment. First cost and upkeep must be brought into the problem.

Six years ago the writer had his first experience with a type of setting for preheating a portion of the air supply, and introducing it over the fuel bed. Air for combustion was introduced under the grates in the usual way at boiler-room temperature, but a portion of the same supply was bypassed through conduits encased in the furnace walls and discharged over the fire at the front of the furnace. The ducts were proportioned in accordance with the gas areas through the setting, breeching and stack and with the quantity and kind of fuel to be burned, the flow through the ducts being unrestricted and proportional to the resistance through the fuel bed. In other words, the thicker the fuel bed the greater the differential between ashpit and furnace, so that more air will be drawn through the ducts. Thermometers inserted near the outlets of these ducts have shown temperatures up to 750 deg. F. The system was applied to four return-tubular boilers, 72 in. by 18 ft., equipped with hand-fired, inclined stokers and served by a stack 72 in. diameter and 125 ft. high, giving a draft over the fire of 0.24 in. The fuel consisted principally of bituminous coal on top of which a certain amount of shavings and wood refuse from the factory were burned.

Before the duct system was installed, the demand for steam was such that all four boilers often were required to carry the load. It had been necessary to force the fires to such an extent that objectional smoke was produced. Fires had to be cleaned every two or three hours, large clinkers were formed and considerable unburned coal passed into the ashpit.

After the air ducts had been incorporated in the setting, the load was carried on three boilers and at times with two boilers. The fuel was burned without smoke, the firing was lighter, the draft available over the fire increased to 0.35 in., and the clinkers almost wholly disappeared. An intense fire could be maintained with one ashpit door closed and the stack damper partly open. As shown by evaporation tests and flow-meter readings, boiler capacities were increased so that operation could be maintained at 200 per cent rating throughout the entire day, the efficiency averaging close to 70 per cent.

Four years later changes were made in the plant, the four tubular boilers were removed and a new boiler room erected and equipped with one 2,000-sq.ft. and two 3,000-sq.ft. water-tube boilers to operate at 175 lb. pressure served by a cast-iron economizer having 3,570 sq.ft. of surface and induced-draft equipment. Under two of the boilers chain grates were installed and a hopper-feed, hand-operated, inclined stoker under the other boiler.

With a new installation of this character it was not thought that any auxiliary equipment would be needed to stimulate combustion. The new boilers, however, did not burn the fuel as clean as the old ones did, nor as free from smoke. They were not responsive and did not meet satisfactorily sudden changes in the load.

The decision was made to come back to the use of preheated air over the fire. The first installation was made on the boiler equipped with the hand-operated stoker; just recently one of the other two boilers was equipped in a similar manner, and the third boiler will be in the near future. A noticeable improvement was soon evident in results. It was found possible to operate the boilers up to 300 per cent of rating. Following a run of six weeks, there were only three wheelbarrows full of deposit in the combustion chamber instead of the usual twenty in a four-weeks' run.

Previous to the use of preheated air it had been the custom to clean the economizer once every week and an average of 25 wheelbarrowfuls of deposit was removed. After the installation of the air ducts the economizer was allowed to run six weeks without cleaning; at the end of that period the accumulation filled only five wheelbarrows.

During the summer it is possible to carry the bulk of the load on one of the larger boilers, so that it was not difficult to obtain comparative results from these two boilers, No. 2 being equipped with air ducts in the side walls of the setting and No. 3 having the usual chain-grate installation. Indications were that the special setting supplying preheated air was saving about 3 tons of coal per day of 24 hours out of a total of 21 tons. To check this estimate, each of these boilers was placed in service on alternate days. Hourly records for ten hours on the regular day run were taken.

With No. 3 boiler the evaporation averaged 8.25 lb. per pound of coal and the rating about 150 per cent. Taking the total heat in the coal and in the steam above the 206-deg. feed water in the heater, the efficiency over boiler and economizer approximated 70 per cent.

No. 2 boiler using the preheated air operated at nearly 200 per cent of rating at an evaporation of 9.71 lb. and the over-all efficiency was 82.3 per cent.

In explanation of this exceptional efficiency in an installation of the character described, it may be stated that the surfaces in both boiler and economizer were clean, the economizer was exceptionally large for only one of the three boilers, and, lastly, the use of the preheated air over the fire improved combustion and raised the temperature of the gases, so that the absorption of heat by both boiler and economizer was considerably above the average.

FRANK ORY, Chief Eng.,
Chicago, Ill. S. Karpen & Bros.

Practical Tool for Turning on Flanges

The usual method of tightening flanges on a pipe is to use a bar across two bolts placed through holes in the flanges. Frequently, trouble is had with the bar

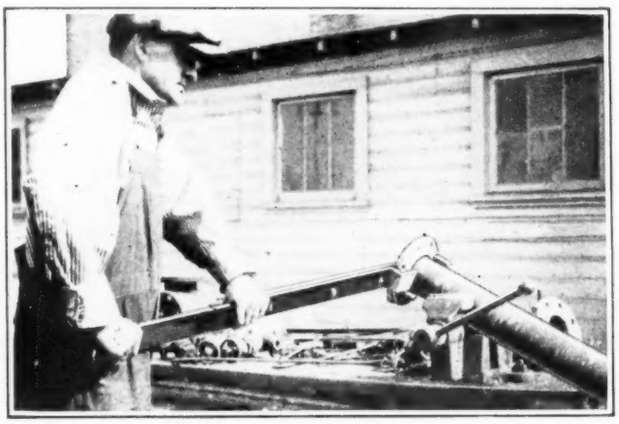


Fig. 1—Design of bar obviates trouble from slipping

slipping unless the bolts are a good fit in the flange holes.

The illustration shows a practical tool we have made at our plant to eliminate the trouble from the bar slipping. For the smaller flanges two pieces of bar iron

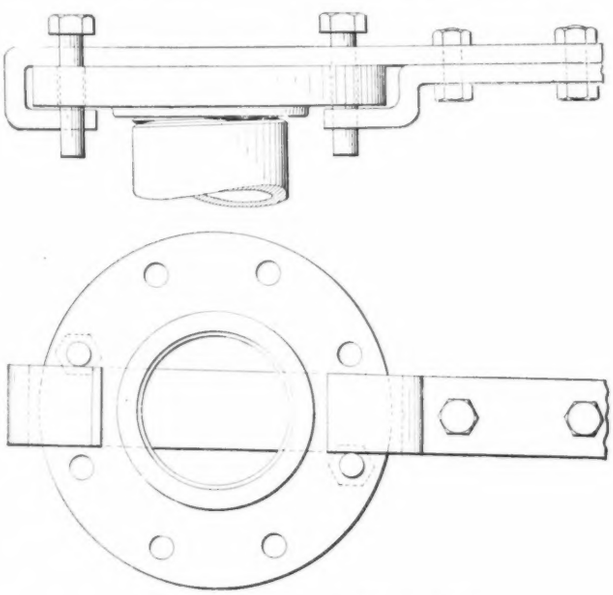


Fig. 2—Detail of flange tool

½x2 in. are used, and they are bent at the one end to fit over the flanges, then bolted together, as shown in Fig. 2. To suit the bar to various sizes of flanges, the bolt holes can be so arranged that by moving one bar either way one hole, the next size of flange is accommodated. The illustration is self-explanatory.

Waterloo, Iowa. G. E. RATH.

Comments from Readers

Painting Pipe Lines

I have read the articles on painting pipe lines that have appeared in *Power* from time to time, and I cannot agree with some of the arguments against it advanced by Raymond L. Drew, in the Aug. 17 issue.

He is of the opinion that the saving or convenience the coloring method affords is not worth while, from which I conclude that his plant is not large or his pipe system is comparatively simple so that he knows each line on sight.

In our plant there are over 50 miles of piping, from ¼ to 14 in. in diameter. These lines pass through ten different tunnels from the power house to the many buildings they serve. Steam, water, gas, air, oil, acetylene and sprinkler lines are all painted, each a distinctive color. In case of trouble, a pipefitter or foreman can tell at a glance just what each line contains. This obviates any guesswork, as each line is instantly identified. In my opinion all lines should be painted, and it does not cost any more to paint them different colors than all one color. We do not paint our pipes just for "the engineer's convenience," but for the benefit of all who are concerned with the inspection and upkeep of the piping system. LEEDS C. WHITE.

Bay City, Mich.

To College Seniors

I have read the letter by C. M. Durgin, entitled "To College Seniors," in the Aug. 3 issue, and inasmuch as my own experience has been closely in accord with the schedule laid down therein, I feel inclined to say I agree with him entirely. There is, however, one factor that might well be developed further, and to which Mr. Durgin refers only indirectly.

With but rare exceptions, the college graduate is "green." No other word will express it. He has little or no personal knowledge of the practical phases of conducting business, of the laboring man's philosophy, or of the thousand and one practical applications of his "book learning."

Until he becomes personally conscious of his shortcomings in this respect, there is little probability of his adopting the fundamental program suggested by Mr. Durgin. He must realize that, regardless of his having struggled manfully through four or five years of college and having had conferred upon him an impressive sounding degree with "all the privileges attached thereto," he is merely on the threshold of his career instead of in the private office.

"Hard-headed business men" are not so foolish as to put "green" college graduates in authoritative positions. If they did, their enterprises would shortly be tremendously disturbed. The college graduate must accept the fact that he is obliged to serve his "apprenticeship" before he receives that investment of authority and business position that he honestly desires.

I may be criticized for using so crude a term as "green" in characterizing the college graduate. Far be it from me to apply to others a term that I would not wish to have applied to myself. I cheerfully and willingly admit that of all "green" graduates, I was perhaps the "greenest." It is a fact that during the first six months after I graduated, I committed such errors and mistakes that at times I almost doubted my good sense. Yet I kept striving and have achieved some measure of success, but only after I acknowledged my limitations and adopted the principle of starting at the bottom and accepting bottom wages.

Nor would I leave the impression that there is necessarily any stigma attached to this particular state of "greenness." The stigma would apply only in case the individual was content to remain so.

Topeka, Kan. H. M. NAYLOR.

The Salesman's Value to the Engineer

Considerable might be said in support of L. A. Cowles' letter in the March 30 issue on "The Salesman's Value to the Engineer" and B. Marker's discussion in the July 20 issue. I agree with both on certain points. Much useful information is obtainable from salesmen, and I can see no reason why they should not be held responsible for their products as explained by Mr. Cowles. Yet, at the same time there is no reason why each salesman cannot visit the plant and confer with the engineer, and if he has something better he can make his product known and become the consultant to the engineer in his line in place of the "vanquished" salesman. The engineer in that way becomes the judge or executive, as desired by Mr. Marker.

Many large central stations follow the plan outlined by Mr. Cowles, to some extent at least. A product is installed and if it does not give satisfactory service the salesman is called in, and if possible he makes it operate satisfactorily. He also calls from time to time and gives the engineer the value of his further experience with other installations, and the engineer profits thereby. Other manufacturers in the same line may soon come out with a new and better device, and the competing salesmen may call on this selfsame engineer and convince him that their new product is better than the one he has installed, and if he decides to give the new device a trial the competing salesman forthwith becomes a competing consultant, and perhaps in time will have the plant completely equipped with his device.

On the other hand I am familiar with a municipally owned power plant in one of the Midwestern states that is managed by the aldermen of the city. One of the aldermen, a plumber, being the closest approach to an engineer on the city council, is in direct charge of the city power plant. This plant has a capable engineer, but the plumber, having been elected to the office and considering himself the employer of the engineer, assumes full authority and acts as designer, purchaser, employer, etc. Recently, some new boilers and an engine

were installed, and he allowed a salesman representing one of the companies to lay out the new plant and specify the complete equipment.

Not long ago I met the engineer of this plant and in our talk learned that there are many things radically wrong with it. The steam pipe to the engine, for example, is about one-half as large as it should be. The exhaust pipe is so small that an excessively high back pressure is built up. The design of the plant is such that additional boilers and engines or turbines cannot be installed without making the plant a worse hodgepodge than it is now.

The boilers, engines and much of the other equipment are modern and in good condition, but it is certain that these units are not piped together and arranged correctly, and as a result privately owned power plants in the same territory are underselling the municipally owned plant by a wide margin.

A consulting engineer experienced in power plants should have been employed by the city council rather than placing such an important matter entirely in the hands of a plumber. The plumber would have done much better had he turned the matter over to the engineer and allowed him to follow Mr. Cowles' plan.

In designing a plant the only thing to do is to let an experienced power-plant engineer do the job. Then after it is designed and built, the engineer in charge would, in my opinion, do well to follow Mr. Cowles' plan, listen to salesmen, adopting devices that appeal to him as being best, at the same time giving all salesmen representing reputable firms an equal opportunity to improve the plant. At the same time he should keep up to date by reading a good power-plant paper.

Newark, N. J. S. F. WILSON.

Why Call It a Diesel?

The editorial "Why Call It a Diesel?" in the Aug. 24 issue, has caused me to delve somewhat into a number of books on internal-combustion engines. I remember the name Ackroyd from the days when I was a student in college, but I did not know that Ackroyd was the real father of the oil engine. The books I have before me now do not mention that fact, and I have Dugald Clerk, Hutton, Hiscox, Carpenter and Diederichs, Perry, Robinson, Lucke, and the "Encyclopedia Britannica."

Doctor Diesel himself never claimed that his engine performed strictly in accordance with the cycle that he admitted is ideal—the Carnot cycle. He did try to produce an internal-combustion engine that would operate on that cycle, but he found it impractical. Nobody seems to question that fact.

Ackroyd did not dispense entirely with ignition paraphernalia; he used a red-hot chamber.

Robinson wrote in 1902, from University College, Nottingham, England, regarding the Diesel engine: "The action is like that in the early form of the Ackroyd engine with extremely high compression." This is the only place where comparison is made in any of the books.

Prof. John Perry wrote, in 1899, regarding the Hornsby-Ackroyd engine: "The oil is injected into the cylinder, or rather into a very hot recess at the end of it, and vaporized there." That is not the Diesel method. In the same book, while commenting on efficiency due to increased compression, Professor Perry said: "The first engineer who has tried to carry out the idea has met with wonderful success in the Diesel motor."

In Carpenter and Diederichs, written in 1908, I find this: "Other engines of this type brought out in this period are Spiel (1884), Capitaine (1885-90), Priestman (1889), Hornsby-Ackroyd (1892), Banki (1894), and Haselwander (1898). One of the greatest achievements of this period is the development of the Diesel engine."

This is the way Dugald Clerk described the Hornsby-Ackroyd engine in 1896: "While the piston is moving forward, taking in the charge of air, the oil which has been thrown into the vaporizer is vaporizing and diffusing itself. . . . On the return stroke of the piston air is forced through the somewhat narrow neck into the combustion chamber, and it there mixes with the vapor contained in it. At first, however, the mixture is too rich in inflammable vapor to be capable of ignition. As the compression proceeds, however, more and more air is forced into the vaporizer chamber, and just as the compression is completed the mixture attains proper explosive proportions. The sides of the chamber are sufficiently hot to cause explosion, and the piston moves forward under the pressure of the explosion so produced."

The foregoing Hornsby-Ackroyd cycle is certainly vastly unlike the present Diesel cycle. Whether or not this cycle was developed by Ackroyd alone, Dugald Clerk does not state. The name Hornsby comes first. In fact, Clerk does not describe the Diesel cycle at all. Evidently, he himself was not familiar with the Diesel motor at that time. He *does* mention a patent taken out by Diesel in 1892, but he says nothing about Ackroyd patents. Hornsby's patents are listed, not Ackroyd's.

In Marks' "Mechanical Engineers' Handbook" six cycles are mentioned: Carnot's, Stirling's, Ericsson's, Otto's, Joule's, and Diesel's. Ackroyd is not mentioned. The definition of the Diesel cycle given therein is: "In the Diesel oil engine air is compressed to a pressure of about 500 lb. per sq.in. Fuel is then injected into the air and, as the temperature is above the ignition point, burns at nearly constant pressure. Adiabatic expansion of the products of combustion is followed by exhaust and suction of fresh air, as in the Otto cycle."

There *is* such a thing today as a "Diesel cycle." That cycle approximates the so-called constant-pressure form. There is no other oil-engine cycle like it. A Diesel engine indicator diagram resembles a steam engine diagram more than does that of any other internal-combustion engine.

This writer maintains that there is sufficient distinctiveness about the Diesel cycle today to permit it to stand out alone in the oil engine field. If one merely uses the term "oil engine," it is commonly understood to cover all ranges of low compression pressures, while "Diesel engine" means high compression, high-pressure injection, no ignition devices, greater weight per horsepower, higher first cost and highest thermal efficiency.

We now have modifications of Diesel engines which are usually indicated by the name. Thus if it is an Air-injection Diesel, it is so called. Some are called "Semi-Diesel." Some are called "Two-cycle Double-acting Diesels." There is the "Supercharging Diesel," and so forth. There is less misunderstanding, so I claim, with the present method in vogue than would be the case if we called them simply "Oil Engines," or "Ackroyds."

There is as much difference between a Diesel and other oil engines as there is between an automobile and

a flivver—as much as between a uniflow steam engine and an ordinary slide-valve steam engine.

Newark, N. J. W. F. SCHAPHORST.

[Note: The Hornsby-Ackroyd hot-bulb engine did not cover all of Ackroyd's patents, and the one which provided for fuel injection late in the compression stroke was never actively developed by the Hornsby firm. —Editor.]

Are Welded Pressure Vessels Safe?

I do not share the author's opinion that "the precautions that insure safety in a riveted vessel will do the same for a welded vessel," quoted from the article "Are Welded Pressure Vessels Safe?" appearing in the June 8 issue.

It would appear that nowhere can faulty workmanship be hidden so effectively as in welding. Machinery and methods used in riveting have practically eliminated the necessity for skilled workmen. Industry's greatest problem today is that of man-power and it is, therefore, but a logical development that those qualified by experience in the problems of the fabricating shop should consider the importance of human element in welding as paramount. The author has undoubtedly also considered its importance, for in stressing the necessity of experienced welders on pressure vessels, he states, "Like all other workmen, he would be tempted to slight the job at times, perhaps from fatigue or impatience." Engineers and fabricators know what a rivet will do and before accepting welding must know what a weld will do. It is my opinion that welding at present depends largely on the skill and conscientiousness of the individual welder.

Investigations of pressure-vessel failures disclose the lack of uniformity of welds and fully support the position taken by the Bureau of Locomotive Inspection that the fusion process has not reached a state of development where it can be depended upon in boiler construction and repair. I quote from the January, 1926, issue of the *Railway Mechanical Engineer:*

> The fourteenth annual report of the chief inspector of the Bureau of Locomotive Inspection to the Interstate Commerce Commission for the year ending June 30, 1925, again emphasized the fact that the autogenous welding of parts of the locomotive or tender, where through the failure of such parts there is a possibility of accident and injury to persons, had not yet reached the stage of its development where it could be used with safety. In the thirteenth annual report, an abstract of which was published in the January, 1926, issue of the *Railway Mechanical Engineer*, attention was directed to accidents investigated where welds made by autogenous process were involved. It was stated in that report that approximately 78 per cent of autogenously welded seams involved in firebox failures were torn, while only 15.4 per cent of riveted seams involved had failed.

Examination of a wrecked brine cooling tank disclosed that the weld extended in some places to a depth of but $\frac{1}{16}$ in., or but one-sixth of the thickness of the plate. A tank used as a generator and absorber in connection with a refrigerating system failed in one of the welded head seams, and while the exact cause of the explosion is not given, an excerpt from the verdict of the coroner's jury composed entirely of refrigerating engineers, states: "The cause of the explosion was due to faulty welding and failure of safety or relief valve to work at proper pressure. Had the tank possessed a sufficient factor of safety, it is not unlikely that it might have held out long enough to release the safety valve."

Another explosion was that of a sulphate digester 72 in. in diameter, 25 ft. high, of $\frac{1}{2}$-in. steel plate, and welded construction throughout. For about one-third of the distance around the lower seam there appeared to have been little of the metal actually joined in the weld. The only portions of the defective part of this joint that appeared to have been welded properly were at the edges of the scarf.

Such failures have not been confined to working installations alone. An electric-arc welded tank, 60 in. in diameter by 7 ft. long with $\frac{3}{8}$-in. shell and $\frac{1}{4}$-in. heads, and intended for oil storage failed while being tested by the builder at 15 lb. air pressure, a regular practice in many boiler shops. Tests of the safety valve immediately after the explosion showed that it released at 15 lb. pressure. Subsequent examination of the longitudinal weld revealed a portion that was poorly welded, representing more than one-third of the total length. The failures cited were obtained from "The Locomotive," issued quarterly by the Hartford Steam Boiler Inspection & Insurance Co.

The January, 1926, issue of *Refrigerating Engineering* contained an abstract of a paper on "Tests on Welded Pressure Vessels," presented before the twenty-first annual meeting of the American Society of Refrigerating Engineers. The lack of uniformity in welds is quite apparent in the discussion which followed and from which I quote. Speaking of "A" tanks, the article states:

> The weld, which has much the appearance of a weld that is too porous to be considered a good weld, while it held enough to deform the center of the head, yet cracks developed in the deposited metal which caused leaking and constituted the cause of stopping the test before complete rupture. Besides the weld being too porous, it also shows lack of penetration. . . . This defect can be laid to the operator. He was not holding the arc against the parent metal enough to form a plastic surface for deposition of metal.

About "C" tanks they say:

> The welding, while electric, is not to be called good. It shows evidence that the operator does not give attention to touching parent metal with the arc, but allows the arc to play on metal already deposited, melting it and allowing it to flow over against the sides of the V, where no arc has yet touched.

and about "F" tanks, "welding was not uniformly good."

So prominent an authority as J. H. Edwards, assistant chief engineer, American Bridge Co., had this to say before the annual meeting of the American Welding Society, April 21-23:

> Fabricators from years of experience have learned the virtues and weaknesses of rivets, and know how to use them so as to make economical and safe structures. What they are seeking concerning welding are the fundamental facts on which they may base their determinations of the strength. When human life is in jeopardy, one must be cautious. He must know the foundation on which he builds and be reasonably sure of the results obtained.

There is a field of usefulness for both welding and riveting, and the foregoing is presented to *Power* readers with the object of presenting the "riveters' side" as it appears at present, in a fair and impartial manner. It is hoped that those interested in the commercial application of welding will appreciate the spirit in which these data are presented.

A. F. JENSEN, President,

Chicago, Ill. Hanna Engineering Works.

New and Improved Equipment

Brown Electrically Operated Flow Meter

Self-Adjusting Inductance Bridge Basic Feature of the Meter—Divided Inductance Coils in Meter and Instruments Operate in Parallel—Inductance Varied by Differential Pressure at Orifice

AN ELECTRICALLY operated flow meter of the indicating, recording and integrating type embodying a number of special features has recently been developed by the Brown Instrument Co., Philadelphia, Pa.

The instrument consists essentially of an electro-magnetic manometer in which the two pressure chambers or legs of the U-tube are connected to either side of an orifice inserted in the steam line or flow to be measured, an indicating meter, and a recording and integrating meter. The manometer is placed at some point adjacent to the orifice of the pipe, while, owing to the electrical principle of operation, the meters can be placed any distance away or in any convenient location as best suits installation requirements.

As shown in Fig. 1, manometer A operates in response to the differential pressure caused by flow of the fluid through an orifice B in the steam pipe or other line. When the rate of flow increases, mercury is depressed in chamber A_1 and rises in chamber A_2, the difference in mercury level in the two chambers being a measure of the rate of flow through the orifice. When the flow increases from zero to a maximum value, a float which rides on the mercury surface in chamber A_1 is lowered from the position indicated by dotted lines to a lower position, as indicated by the solid lines. The float is made of non-corrosive metal, and chamber A_1 has a molded bakelite lining, ribbed on the inside, to insure freedom. An armature C of laminated iron is supported by the float on a non-magnetic rod D and is raised and lowered in accordance with the motion of the float. The armature travels inside of a non-magnetic tube in which the pressure of the fluid being metered is also confined. The divided inductive winding E and E_1 is placed over the outside of the tube and is under atmospheric conditions only and is protected by a cover.

The outer ends of the divided winding E and E_1 are connected directly across the service mains of an alternating-current supply line, and connections are run from these ends directly to the outer ends of a similar divided inductance coil F and F_1 of an indicator H and the coil G and G_1 of the recording instrument I. Armatures are hung on counterbalanced arms J and K in the two instruments. The points of connection between the two parts of the coils E and E_1, F and F_1 and G and G_1 are all connected together by a neutral wire P, and when thus connected the coils form the self-adjusting inductance bridge which is the outstanding basic feature of the meter.

When the armature C in the manometer is raised or lowered by a change in flow through the orifices, the relation between the voltages across the two parts E and E_1 of the winding will be changed. This causes the currents in the two parts F and F_1 of the indicator coil, and also the currents in the two parts G and G_1 of the recorder coil, to become unequal; as a result the armatures of the indicator and recorder move to new positions corresponding to the position of the armature C, and the meter readings are

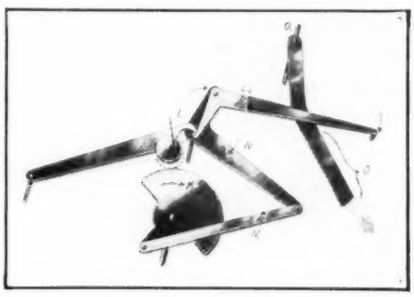


Fig. 2—Mechanism for reproducing square-root law

adjusted accordingly by means of the gearing or linkage shown. In this way the operation of the instrument is independent of the actual value of the line voltage.

In order to make use of the simple inductance-bridge method of operation, a special type of integrator is used which increases the counter readings in proportion to the square root of the angular deflection of the recorder pen arm, this being the relation of flow to the pressure difference across the orifice. Attached to the gear train which drives the recorder chart is a sector of a disk K, Fig. 2, which

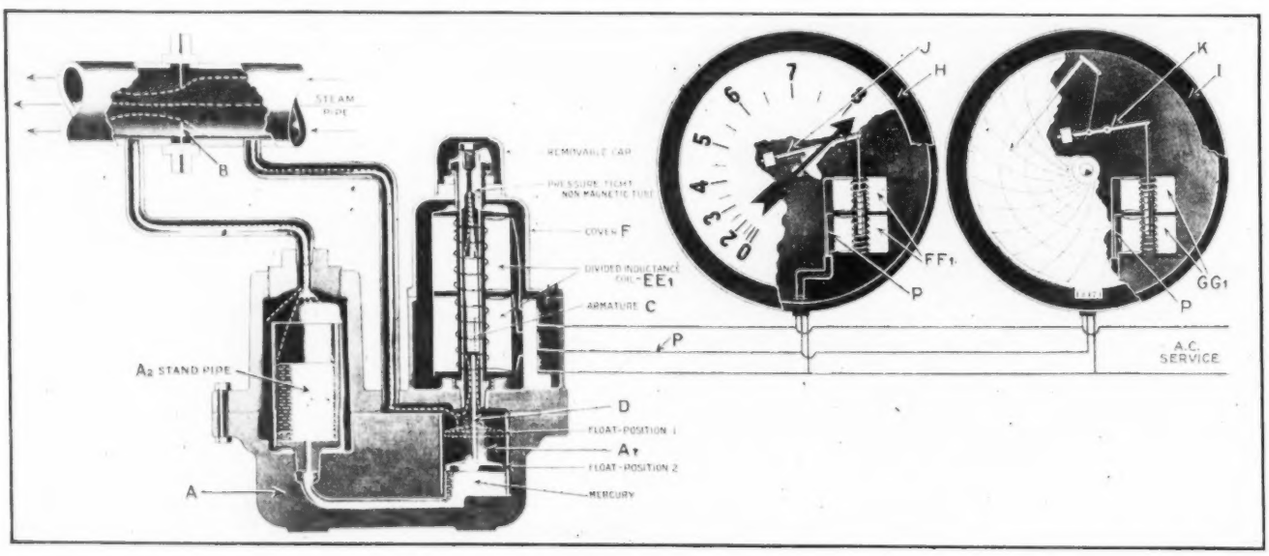


Fig. 1—Sectional and cut-away views of the manometer with indicating and recording instruments

rotates at a constant rate. A roller L is normally held up by latch L_1, out of contact with the sector. The latch is tripped when the sector is in different positions, depending upon the rate of flow, and the roller is rotated through an angle proportional to the rate of flow before the sector passes out of contact with it. After the sector passes beyond the roller, the latter is again latched up by L_1 and the process repeated at regular intervals.

The square root relation existing between the rate of flow and pressure difference is reproduced in the relation between angular travel of the disk L

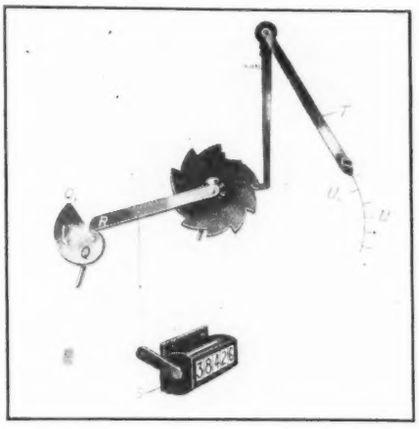


Fig. 3—Counter and recorder operating mechanism

and pen deflection by means of the oscillating latch carrier N being driven by the rotating sector K, through a link N_1 shown in Fig. 2. Tripping blade O, which is attached to the recording pen shaft O_1, releases the latch at the proper point, according to the reading of the instrument.

When roller L has turned through a definite number of revolutions, a pawl is released, which thereupon engages with a toothed pinion of the chart-driving gear train. This causes a cam Q, Fig. 3, to make one complete revolution after the pawl is released, and the cam then remains at rest until the roller again completes the proper number of revolutions.

As the cam Q advances, a cam arm R is gradually raised, lifting the arm of ratchet counter S until the high point Q_1 of the cam passes, then the cam arm falls quickly and advances the reading of the counter by one unit without allowing the figures to pause in a halfway position. Each time the cam arm falls, the recording pen T makes a jog U in its record line, every tenth jog U_1 being in the opposite direction to facilitate counting when desired.

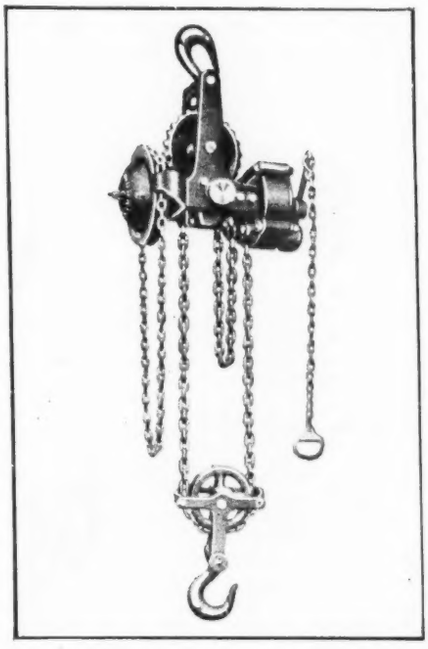
A series of printed charts are chosen with a fixed ratio between successive ranges. The manometers also are arranged to be adjusted for several appropriate ranges. This simplifies the choice of an orifice plate, the size of which depends chiefly upon the density of the fluid and the pipe size. With such an orifice the apparatus is easily adjusted for successive chart ranges by using a stand-pipe of proper size in the manometer. This is useful where the average load changes from time to time, for then the apparatus can be readjusted by changing the manometer stand-pipe instead of changing the orifice plate.

The various manometers for use with steam, operate on successive maximum pressure differentials increasing by intervals of about 60 per cent, ranging from 1.6 to 16 in. of mercury. There are six ranges in this series, the choice of a suitable manometer depending upon velocities encountered.

Where the apparatus must work on very low-pressure differentials, an especially sensitive type of manometer is provided, the most sensitive of which gives full deflection of the meter on a pressure difference of ½ in. of water.

Morris Gravity-Lowering Chain Block

The gravity-lowering chain blocks, illustrated, are being distributed by Herbert Morris, Incorporated, Buffalo,



Gravity-Lowering Chain Block

New York. The hoist is built in five sizes ranging from ½ to 5 tons capacity.

The frame is made of rolled steel plates and forgings. The hoisting mechanism consists of a worm and wheel, the wormwheel being integral with the load chain wheel. The worm has a double thread, and its lead is large enough to allow the wormwheel to drive it when a load is placed upon the hook. The worm and shaft are turned from the solid and are heat-treated and ground. The thrust is taken on ball thrust bearings. On one end of the wormshaft is mounted a centrifugal brake that keeps the lowering speed within safe limits. When the hoist load is allowed to lower by gravity, an automatic stop actuates a brake when the hook reaches its lowest position.

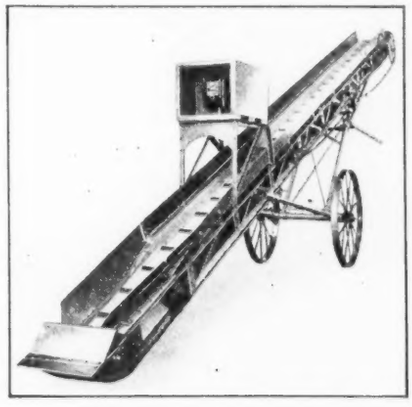
The hand-chain wheel is provided with a runaway clutch so that it does not move while the hoist is gravity lowering. The load may be lowered in the usual way by pulling on the hand chain in order to provide accurate placement of the load if desired. An automatic brake on the wormshaft sustains the load whenever the hand chain is released. The pull at the hand chain for rated loads ranges from 75 lb. for ½-ton hoist to 160 lb. for 5-ton hoist. The lowering speed varies from 60 to 12 ft. per min. respectively. The ½-ton hoist has a clear lift of 8 ft., while the 5-ton has a clear lift of 12 feet.

Improved Jeffrey Portable Conveyor

A number of improvements have been made on the portable conveyor put out by the Jeffrey Manufacturing Co., Columbus, Ohio, with a view to making it more practical in handling coal and other materials from hopper-bottom railroad cars to storage piles and trucks and for reclaiming from storage piles.

The improvements include a change in the steel sideboards to provide larger capacity, an improved type of idler for carrying the loaded portion of the belt, an extended and flared loading leg at the bottom and an improved gate at the foot of the conveyor to prevent material from falling into the enclosed boot housing.

The conveyor is built in 18-, 24- and 30-ft. lengths and is furnished with



Improved portable conveyor

electric-motor or gasoline-engine drive. The belt provided with the conveyor is 16 in. rubber covered.

West Kootenay Power Plans Another Development

Announcement of another large development by the West Kootenay Power & Light Co., of West Kootenay, British Columbia, to cost approximately $300,000, was made recently by L. Campbell, general manager of the company. This will be the hydraulic development of 60,000 hp. one mile down the Kootenay River from the Lower Bonnington Falls. The work will be started immediately.

Dipping and Baking Motors Keeps the Day of Trouble Away

DIPPING the coils of an electrical machine in an insulating varnish and baking them before placing them in the machine and the dipping and baking of the complete winding, has become quite general practice in manufacturing as well as in repair shops. Recently, the Power Committee of the National Electric Light Association issued a report on "Baking Armatures and Insulated Coils in Electric Ovens." In this report it is stated that the practice first demonstrated its great value, in making savings and promoting reliability of electrical machinery, on railway-motor armatures. An increase of 75 per cent in the life of motors that have been dipped and baked is not uncommon. Besides this direct saving there is the great gain due to freedom from failures and breakdowns in service.

EXPERIENCE has shown that dipping the armatures and field coils of motors in a good insulating varnish and then baking them in an oven increases the life of the motor 75 per cent. Although the information given in this report is intended primarily for use in large shops, there are many helpful suggestions on the selection and use of insulating varnish for those that have only an ocasional motor to repair. If this method of treatment has proved successful in putting off the day of trouble, where a large number of motors are involved, then those who have only a few machines may well give careful consideration to its adoption.

Reason for Longer Coil Life

The reason for the longer life and improved reliability of coils and windings that have been dipped and baked, is that the insulating varnish, properly applied and baked, forms a hard coating, impervious to moisture, which fills all the cracks and crevices, holds loose coils and laminations in place, restores coil insulation to good condition and prevents the entrance of dirt and moisture.

Proper treatment of coils and windings involves three essentials:

1. Use of suitable baking varnish.
2. Thorough impregnation of the coils.
3. Uniform baking at the correct temperature.

A large part of the report is devoted to an extract from an A.E.R.A. paper, "Certain Essentials in Drying and Baking Railroad Armatures," by H. S. Day. Although this paper was prepared as applying to railway armatures, it contains much that applies equally well to industrial equipment. In the following, parts of this paper are reproduced:

Object of Armature Dipping

The object of dipping an armature in an insulating varnish and then baking dry is to encase the wires and coils in a hard, gum substance that will, by completely surrounding the coil, prevent chafing, lessen vibration and repel moisture and oil, all of which would, sooner or later, break down the original insulation and cause grounds or short-circuits.

The process of dipping and baking is neither difficult nor complicated, but it is exacting, and certain stages of the treatment must be carried out without deviation from proved standards. The three important conditions that must be observed are: First, the armature must be free from all dirt and moisture; second, all windings must be thoroughly saturated with varnish and the surplus drained off; third, the varnish must be baked dry.

Dipping in varnish an armature that is not clean and dry will defeat the purpose at the start, because dirt and moisture trapped in windings by hardened varnish will quickly cause insulation breakdowns.

The same criticism applies to the dipping. If all wires and coils are not thoroughly saturated with varnish, the result is again defeated, because it allows open spaces for the accumulation of oil, dirt and moisture.

Finally, and undoubtedly most important, if the varnish is not baked dry, the coils are simply supplied with moisture before the motor has a chance to pick it up in service.

Cleaning an Armature

The universal practice in cleaning an armature preparatory to dipping is to blow the dirt out with air pressure, and this is probably the most practical, but the air must be dry. After the dirt is all blown out, the entire armature should be thoroughly wiped off with gasoline. An excellent practice is to dip the armature in a vat of gasoline and move it around in the gasoline until all oil and dirt are removed. The only objection to this is the danger from fire from exposed gasoline, but if thoroughly done, blowing out and wiping will obtain good results. Air pressure should not be too high, 50 to 60 lb. being sufficient. After the armature is cleaned, it should be placed in the oven and kept there 10 to 12 hr. at a constant temperature just high enough to dissipate moisture.

At the end of the preheating period the armature must be allowed to cool off so as not to enter the varnish too hot. The correct temperature is from 55 to 60 deg. C. (130 to 140 deg. F.), or when a workman can comfortably lay his hand on the core. The reason for this is that if the armature is too hot, the varnish will be heated, become too thin and run off, leaving the armature with too thin a deposit of varnish.

How To Dip an Armature

There are many different opinions as to how the armature should be dipped, whether it should literally be "dipped" at all; but there is one point about which there cannot be any argument, and that is that the windings should be thoroughly saturated with varnish. It makes little difference how the varnish is applied to the windings, so long as it is thoroughly applied. The simplest and easiest way is to immerse the armature up to the commutator ears in a tank of varnish, pinion end down, for from five to ten minutes. This length of time will be sufficient to allow penetration to the bottom of the slots if proper precautions with regard to maintaining the uniform specific gravity of the varnish are strictly followed.

A careful study should be made of the type of armatures to be dipped, and by experience the operator will soon be able to decide just how to overcome the liability of wet varnish pockets. The important thing is to get rid of the free varnish so that there will be no "pockets" of wet varnish.

Specific Gravity of Varnish

Equally as important as having the armature at the right temperature when it is placed in the varnish, is to have the varnish at the right specific gravity. This is not difficult, but it is very important that it be done consistently. About the most practical way is to use a hydrometer, and with this to keep constant the specific gravity recommended by the manufacturers of the varnish. Most varnishes can be thinned or, as it is called, "cut" by the use of gasoline or benzine. This should be added in small quantities and stirred in, because if a large amount of gasoline is added at one time the gums and substance in the varnish may remain in suspension and not mix. The container for the varnish should have a tight lid, because gasoline and other cutting agents are highly volatile and evaporate rapidly. This is another reason why the hydrometer should be used before dipping is started and frequently while it is being carried on. Gasoline or benzine that has a low kerosene content should be used, as when the kerosene content is high the oil is left when the gasoline is evaporated during the baking period. Gasoline to be used for a cutting agent should test not less than 54 to 56 deg. Baumé. Varnish may be thinned in two ways—by the addition of solvent and by the application of heat.

When the armature is drained, it

should be placed in an oven in which the temperature generally recommended is not allowed to vary either below 115 deg. C. (239 deg. F.) or above 125 deg. C. (257 deg. F.), and kept there without interruption until the baking period is over. It is an excellent practice if the armatures are placed in a horizontal position to turn them every ten to fifteen minutes during the first hour before the varnish is set. This will prevent what free varnish is left from collecting in one spot.

Ventilation of Oven

The oven must be ventilated sufficiently to carry off the moisture and gases given off in the baking process without lowering the temperatures, and the baking period should be uninterrupted.

There has been as much discussion as to what is the correct time to allow an armature to remain in the oven as there has been about how to dip it. Here, again, the point is that the varnish must be baked dry, whatever the time required, and the baking time is governed to an extent by the oven temperatures. A simple way to know when an oven is baking armatures dry is to measure the resistance during the baking period.

The selection of a good baking varnish is important, for poor varnish can cause grief. Air-drying or other insulating varnishes will not give as good results as a baking varnish, although air-drying varnishes are sometimes used. As a matter of fact, air-drying varnish has little protective value and serves more to give a finished appearance to new and repaired work than it does to supply insulation.

Types of Baking Varnish

There are two types of baking varnish, one having a china-wood oil base and one a linseed-oil base. Varnish with a linseed-oil base will not give as good results as a combination varnish containing a larger proportion of china-wood oil than linseed oil. This is a matter for the operator to decide by results obtained. The same thing may be said in choosing amber and black varnish, although it is believed that more gums and non-volatile insulating substances, such as asphalt, can be suspended in the black varnish. The important thing is to select a varnish that is known to be high grade and made for baking.

Electrically heated ovens will produce correct results. Ovens should be thermostatically controlled to insure a constant temperature during the baking period, because if controlled by hand and left to an operator the heat control will be frequently forgotten or neglected. It is important that this should not happen.

There are various designs and kinds of materials for constructing ovens that are more or less standard, and there are at present in operation a number of well-designed ovens of home-manufacture. The principal points to be borne in mind in the installation and operation of a baking oven are: Thorough heat insulation, to prevent loss of heat through radiation and escape through cracks and openings; adequate ventilation, to carry off moisture and gas; and accessibility and arrangement, to cut down handling time.

Two Essential Causes of Caustic Embrittlement*

By F. B. Porter†

The whole idea of caustic embrittlement has been laughed at by chemists and engineers, but contact with one case of this trouble will usually convince the most skeptical that it is a real condition that needs to be studied carefully. On the other hand, many boilers have long been operating on soft, alkaline water at pressures from 150 to 210 lb. that have never shown indications of embrittlement. In several plants an occasional drum has been lost through embrittlement, while other drums have seen the same service with the same water and are still in regular operation.

Like Boilers in Same Plant React Differently to Same Treatment

A report made on a plant that had embrittlement trouble in six boilers lays the trouble to a soft alkaline water. From this report it is easily shown that all the boilers affected came from the boilermakers' shops in two lots and that there are two other lots of boilers in this same plant that apparently received the same water and the same treatment but were not affected by embrittlement. Embrittlement trouble in another plant was attributed to the water, although the plant had operated for a shorter period of time with less concentration of caustic soda than other plants using the same water without trouble. It was found that the steel had been subjected to too great working strains in fabrication or showed improper annealing. Micrographic study of embrittled steel from three widely separated instances of embrittlement seems to indicate that the cracking could be accounted for by the condition of the steel independent of any action of caustic soda or gasses resulting therefrom in the boiler.

The question of the contributing causes of this peculiar type of embrittlement is important in suggesting remedies. This trouble occurs often within six months to three years after the boilers are put in service. The stresses in the metal set up in the fabrication of the drum in the area adjacent to the rivets may be high. It is a difficult question to decide whether boiler water leaking into the seams evaporates, produces high concentration, and starts embrittlement, or whether the embrittlement and cracking start and the leaks result. If the leak comes first, it probably does not make much difference what the concentration of the boiler water is, for the reason that a concentration even to the solid can rapidly occur in the seam as soon as the leak starts, due to evaporation in the seam or crack.

The impression has been general that it is only overtreated, softened waters that would be likely to cause embrittlement. A recent case of embrittlement where zeolite treated water only had been used would indicate that any softened water may furnish one of the requisite causes for embrittlement. The mention of pressure and intermittent operation as compared with continuous operation leads one to the general belief that higher pressures and more continuous operation tend to increase the likelihood of embrittlement taking place, but this is as strong as this statement can be made, for of boilers operating under the same pressure and on the same water some may be affected seriously and others not at all.

Careful Fabrication Important

Both the manufacturer and the user of boilers today are paying more attention to the character and fabrication of boiler steel. Based on present knowledge, this is one of the best precautions that can be taken to combat this source of danger.

In conclusion, it seems at the present time that the only explanation of caustic embrittlement that will account for this condition being present in some drums of some plants and absent in other drums of these same plants, and absent in all the drums of other plants, using the same water, is that embrittlement is due to overstrained or dirty steel and causticity in contact with it.

*The interest and importance of this subject may justify publication of this excerpt from a paper read before a meeting of the American Chemical Society, Tulsa, Okla., April 5 to 8, 1926.—Editor.

†The Fort Worth Laboratories, Fort Worth, Texas.

Furnace Volumes and Heat Liberation with Pulverized Coal

The range of furnace volumes for burning pulverized coal, according to the N.E.L.A. Prime Movers Report just issued, is between 0.35 (at the Narragansett plant, Providence) and 1 cu.ft. (East Peoria Station) per square foot of boiler-heating surface, with a tendency in the newer installations toward the lower rather than the upper limit. This is being brought about by water cooling of furnace walls and means for increasing the turbulence of the coal and air mixture as it is injected into the furnace. Furnaces constructed with refractory-covered water tubes show good performance in elimination of smoke at low ratings and capacity for burning large quantities of coal per cubic foot of furnace volume when the unit is forced to high ratings.

The B.t.u. liberated per cubic foot of furnace volume per hour at maximum ratings in a number of plants reporting varies from 12,450 to 28,450, the latter corresponding to 275 per cent rating at the Mahoningside plant of the Ohio Public Service Company. The highest rating reported was 380 per cent, at the Trenton Channel plant, Detroit. In this case, however, only 19,300 B.t.u. were liberated per cubic foot of furnace volume. The lowest figure reported was 20 per cent rating with 1,600 B.t.u. liberated per cubic foot.

News in the Field of Power

Investigation Reveals Cause of Fatal Boiler Explosion in New York Plant

Cast-Iron Mud Drum Fractured—Trouble Traced to External Corrosion—Criminal Liability May Be Charged

AS REPORTED in *Power*, Sept. 21 a boiler explosion at the Rees & Rees dyeing establishment at 232 East 40th St., New York City, exploded on Sept. 9, fatally scalding three men and slightly injuring a fourth. Thorough investigation bears out the original report that the disaster was caused by the fracturing of the mud drum.

The boiler was of the cross-drum type, having a 42-in. drum 14 ft. in length and 104 four-in. tubes 18 ft. long, and was designed to carry 125-lb. working pressure. It was installed in 1910 to replace a smaller unit and to operate in connection with a second boiler of the fire-tube type. To provide enough headroom, the limited height of the basement necessitated excavation below the basement floor line; as a result the firing floor was about 5 ft. below the floor level. This placed the bottom of the rear headers and the mud drum approximately level with the firing floor, as shown in Fig. 1.

Water Settled by Brickwork

The seepage of water into the basement together with any leakage from water lines, etc., naturally drained into the pit and settled along the boiler brickwork. Nothing prevented this water from flowing in under the mud drum and the deposit of soot, ashes and dirt, as indicated in Fig. 1, became saturated and corrosion set in. As the mud drum and combustion-chamber floor were out of direct contact with the hot gases, the saturated soot seldom if ever dried. Corrosion probably had been going on for several years and when the mud-drum shell became sufficiently thinned, it was unable to withstand the boiler operating pressure. As shown in Fig. 2, a large section of the cast-iron drum broke out.

The released steam blew down part of the side wall of the boiler setting and also forced open the steel doors covering the rear headers. The three men, consisting of the fireman, the coal passer and the assistant engineer, were in the boiler room and succumbed to the hot steam. The engineer was on the floor above and was uninjured.

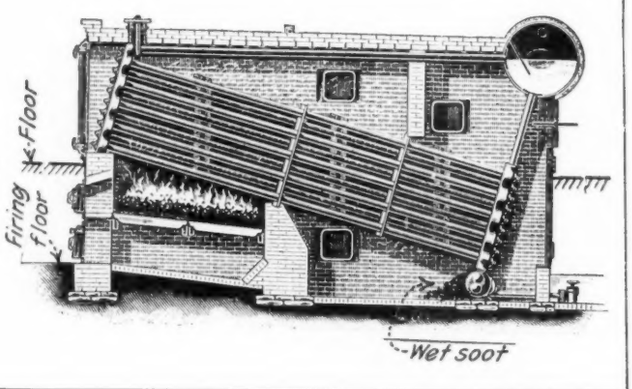


Fig. 1—Sketch of boiler location and soot accumulation

As Figs. 2 and 3 show, the cast-iron drum was badly corroded; the original thickness of approximately ¾ in. was reduced along the break to less than ¼ in. The interior of the drum showed no signs of corrosion, although there was some local pitting and a thin deposit of scale.

From statements made by the engineer and one of the scalded men the boiler pressure at the time of the accident was 100 lb. and the gage had showed no rise in pressure. The boiler had been internally inspected on Dec. 10, 1925, by the insurance company whose policy covered the plant, and on Dec. 18 the inspector of the police department had made the annual external inspection at which time the pressure gage had been tested and found correct. After the explosion the safety valve was tested with water pressure and relieved at 125 lb. which was the allowed boiler pressure.

The police department, as well as the insurance company, has conducted a thorough investigation of the accident, and the illustrations shown are reproduced from photographs taken after the drum had been removed to the sidewalk.

In addition to the drum rupture the

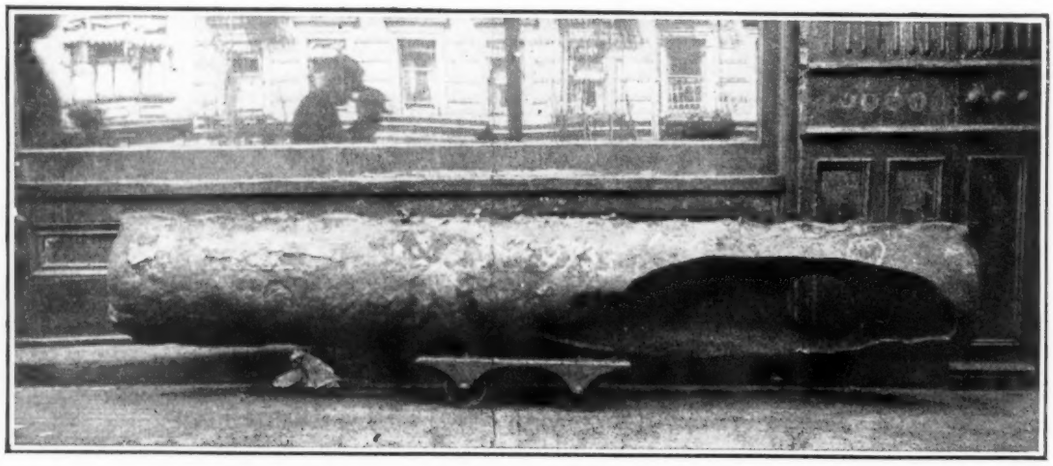


Fig. 2—Fractured side of mud drum showing the extensive external corrosion

falling baffling slightly damaged three tubes. The débris has now been cleared away and a new steel drum is being installed together with three new tubes. The entire baffling was destroyed and one wall of the brickwork must be rebuilt.

The accident is being investigated by the Prosecuting Attorney's office with a view of ascertaining if anyone was criminally liable.

Charles R. Huntley, Noted Power Executive, Dies

Charles Russell Huntley, seventy-two years old, nationally known power executive and president of the Buffalo General Electric Co., died at his home in Lancaster, N. Y., on Sept. 17. He had been ill two weeks with arteriosclerosis, but it had not been thought that his illness was serious.

Mr. Huntley had been a leader in the business and industrial life of western New York for many years, having worked his way up from comparative poverty. He was born in 1853 at West Winfield, N. Y., and was educated in the district schools of that place and in the public schools at Utica.

When he was twenty-one he went to work for the Remington Arms Co. at Ilion, N. Y., and remained there three years. In 1877 he went with the American Transfer Co., an affiliated concern of the Standard Oil Co., at Bradford, Pa. After an exciting career in the oil fields he went to Buffalo and entered the electrical business, in which he later made such a marked success.

His first employment in this field was as general manager of the Brush Electric Light Co. In 1892 this concern was merged with the Buffalo General Electric Co. and he became first vice-president and general manager. In 1906 he was elected president. He also was an officer in many other companies, among them being the Cataract Power & Conduit Co., the People's Bank of Buffalo, the Buffalo & Niagara Falls Electric Light & Power Co., the George Urban Milling Co. and the German Bank of Buffalo. He also had served as president of the National Electric Light Association and as president of the Empire State Gas & Electric Association.

In 1924, realizing the benefit that would result from grouping the various light and power companies controlled by the Buffalo General Electric Co., outside of Buffalo, into one company, Mr. Huntley made arrangements for this combination. In May of 1925 it was announced. This grouping brought the Buffalo, Niagara & Eastern Power Co., the Niagara Falls Power Co., the Niagara Lockport & Ontario Light & Power Co. and the Tonawanda Power Co. under the Buffalo General Electric Co.

After the combination, Mr. Huntley was elected president of the Buffalo, Niagara & Eastern Power Co., chairman of the board of directors of the Niagara Falls Power Co. and served on the directorate of the other companies.

Carnegie Institute To Hold Bituminous Coal Congress

The Carnegie Institute of Technology has announced a conference on bituminous coal to be held at Pittsburgh, Pa. November 15 to 19.

The purpose of the meeting is to consider new uses for bituminous coal and to present the results of recent investigations of coal that are concerned with improved methods of utilization and combustion.

A number of distinguished European scientists will take part, as well as some of the best-known American fuel technologists and engineers. The program will include the discussion of the manufacture of substitutes for gasoline from coal, complete gasification of coal, high temperature distillation, low temperature distillation, coal tar products, power, smokeless fuel, and fertilizers.

The section devoted to the field of power will hold its session Tuesday afternoon, Nov. 16, treating such subjects as "Power at the Mine," "Colloidal Fuel" and "Transportation of Powdered Coal."

Among those who have accepted invitations to be present and to speak are: Dr. Friedrich Bergius, of Heidelberg, Germany, inventor of the Bergin method of the production of oil from coal; Prof. Franz Fischer, director of the Institute of Coal Research, Mulheim-Ruhr, Germany; Dr. C. H. Lander, director of fuel research of the Department of Scientific and Industrial Research, London; Dr. R. Lessing, consultant in Fuel Technology, London; Geoffrey M. Gill, consulting engineer and gas specialist, London; Harold Nielsen, inventer of the L. and N. Process, London; General Georges Patart, of France, inventor of a process for making methyl alcohol from coal; Marius R. Campbell, U. S. Geological Survey; A. C. Fieldner, U. S. Bureau of Mines; John M. Weiss, chemical engineer, New York, N. Y.; C. J. Ramsburg, vice-president Koppers Co., Pittsburgh; S. W. Parr, professor of Applied Chemistry, University of Illinois, and C. V. McIntire, of the Consolidated Coal Products Co., Fairmont, West Virginia.

Papers will be presented by a number of other American and European technologists. Special attention will be devoted to the discussion of recently developed processes which are in actual operation.

An advisory board includes the following men of affairs: Hon. Andrew W. Mellon, John Hays Hammond, Otto H. Kahn, Charles M. Schwab, Samuel Insull, E. M. Herr, and Dr. Frank B. Jewett.

Engineering Council Reports Up for Study

The administrative board of the American Engineering Council will meet at Ithaca, N. Y., November 11 and 12. Reports will be received from numerous committees which have been active during the summer.

Among the topics in the large agenda which is being prepared are safety and production, registration of engineers, government reorganization, and jurisdictional strikes in the building industry. Dean Dexter S. Kimball of Cornell University, the president of the council, will preside.

East Kootenay Power Builds Steam Plant in Alberta

The East Kootenay Power Co., of East Kootenay, British Columbia, has begun work on a $1,000,000 steam power plant at Coleman, Alberta, to generate power for industries in the district.

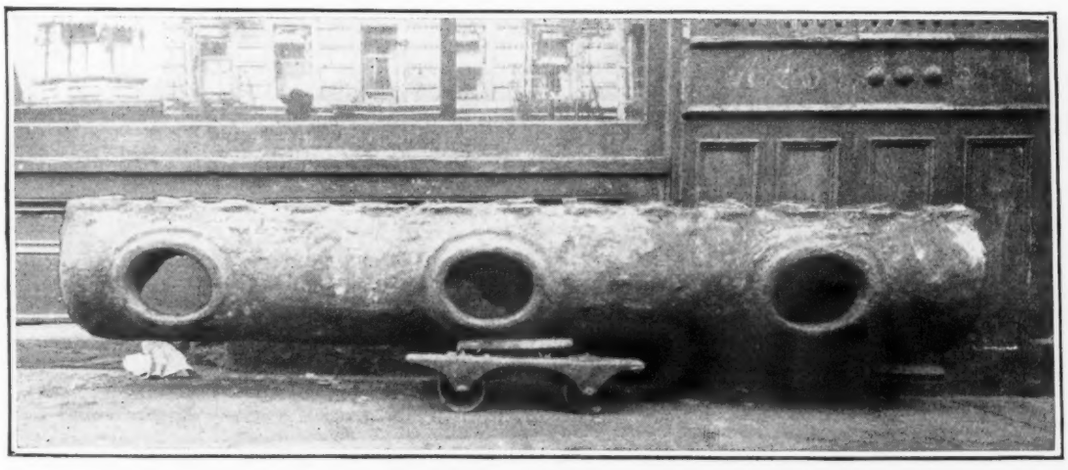


Fig. 3—Rear side of drum photographed by N. Y. Police Department after removal to the street

Henry Ford's Name Is Linked to Passamaquoddy Project

A rumor has recently been set current that Henry Ford is going to back the $100,000,000 Passamaquoddy tidal power project originated by Dexter P. Cooper, engineer.

Mr. Cooper has been in New York City on business connected with the enterprise, and the work of the preliminary survey for the project soon will begin it is understood.

The first intimation that Henry Ford might be associated with the financial end of the project came at a mass meeting at Eastport, Me., in the interests of the land development in the vicinity of Machias. John Douglass Day, of New York, speaker, informed the gathering that prominent New York financiers interested in this proposition have expressed their belief that Mr. Ford is behind Mr. Cooper in his efforts to harness the tides of Passamaquoddy Bay and will furnish most of the money to make Mr. Cooper's idea a reality.

It was stated, also, that "something was to break" soon and this "something" is apparently the preliminary survey, permission for which has been obtained from the Interstate Commerce Commission of the United States and the parliamentary authorities in the Dominion of Canada.

Bids for the survey work are said to have been asked by Mr. Cooper, but all of them were so high that he is reported to have decided to undertake the survey himself. He now has one engineer on the territory, and there are enough local men available to provide the necessary crew, it was said.

Electric Arc Approaches Power of Lightning

Probably the nearest approach yet made to the electric pressure of lightning has been attained in the new Stanford University laboratory with the successful testing of six transformers generating more than 2,100,000 volts.

In the tests there, supervised by Prof. Harris J. Ryan, marking the opening of the laboratory, a group of natural scientists from all sections of the United States witnessed the electrical display in which an arc of varicolored flame shot across a 20-ft. gap between two electrode plates.

The principal object of the tests will be to discover methods of transmitting exceptionally high voltage and to lessen if not entirely eliminate existing losses in power transmission. A large tract, which is part of the laboratory property, will be used in the experiments including the study of the nature of lightning and other problems known as "electrical phenomena."

The tests began with the laboratory in utter darkness. As the generators were started, faint flickers of light issued from the electrode plates. These lights and sparks, alternately violet and white, expanded as the voltage increased, which created a halo, known to natural science as the "corona," which indicates wasting power. When a voltage of 2,100,000 was reached, a ribbon of jagged flame shot between the electrodes.

The laboratory was built for Professor Ryan by Stanford University with the financial aid of power companies. Two years was required to assemble the equipment, including the transformers, which are among the largest ever constructed.

Virginia Electric & Power Enlarges Norfolk Plant

Construction of a $5,000,000 extension to the steam station at Norfolk, Va., operated by the Virginia Electric & Power Co., a subsidiary of the Engineers Public Service Co., is planned for immediate undertakeing.

This work will include the installation of one 30,000-kw. turbo-generator, three 1,700-hp. boilers, and forced draft underfeed stokers, together with coal handling equipment and all necessary auxiliaries, making necessary extension of turbine room, boiler room and switch house to accommodate the new equipment.

The company has authorized Stone & Webster, Inc., to proceed with the design and construction.

The enlarged power supply will take care of the growth of the industrial demand in the Norfolk-Portsmouth district for some time to come. On its completion the Norfolk plant will be the largest electric generating station in Virginia, with about 100,000 hp. capacity.

Irrigation Power Project for Columbia River Planned

A definite plan for financing development of the Columbia River basin is being worked out by Washington state interests, according to Secretary of Commerce Hoover who spent more than a week in that section during his recent western trip. The plan will include ultimate irrigation of some 12,000,000 acres of land as well as power development.

Secretary Hoover said that he believes the irrigation works in the Columbia basin can be handled with approximately $125,000,000 as a revolving fund as the land will pay its way as opened to cultivation gradually. The work would require ten years, it was said, and by the end of that period the growth in population would make it profitable to put the area into cultivation.

Mr. Hoover also gave some attention to the Colorado River problem while in the West. This situation, he said, in so far as an agreement among the states is concerned, is in the same situation as when Congress adjourned. A meeting has been called at Los Angeles to which representatives of Arizona have been invited.

Students of Western School Build Own Plant

A new power and heating plant was recently installed in Western University at Kansas City, Kan., entirely by student labor, under the direction of instructors of the schools, an example of the practical education given in this industrial school of accredited collegiate rank, maintained by Negroes for Negroes.

All the work was done by students, who were paid out of appropriation by the state for the erection of the building, and this payment enabled them to make their way through the school.

The cost to the state, it is reported, was perhaps less than it would have been under contract, because the superintendents of construction received nothing except their regular salaries as instructors in the school. When the job was finished, state officials carefully inspecteed the work and approved it after test. Only certain hours were devoted to construction of the plant, other hours being given to academic work.

Obituary

Edward A. Kolbe, chief engineer of the Union station power plant in St. Louis, Mo. for thirty years preceding November, 1924, and an employee of the Terminal Railroad Association of St. Louis and its predecessors for fifty-six years, died at the St. Mary's Infirmary, St. Louis, on Sept. 18. Mr. Kolbe's first job in St. Louis was as tugboat engineer for the Illinois & St. Louis Bridge Co., which built the Eads Bridge and later became the Terminal Railroad Association of St. Louis. Mr. Kolbe was a native of Germany. The funeral was held on Monday, Sept. 20.

Frank C. Armstead, who died September 7, was employed by the Westinghouse interests in March 1888, and was with that company in the development of the mechanical stoker up to the time of his death.

He was identified with its pioneering, and later with its management, during the greater part of his long career. In recent years he had been acting in an advisory capacity.

Mr. Armstead learned the machinist's trade at 16 years of age. After some years of mechanical and operating experience, he came with Westinghouse, Church, Kerr & Co., first as an erecting man, and soon afterward as superintendent of construction.

Personal Mention

Lester E. F. Wahrenburg has accepted the position of assistant design engineer with the Duquesne Light Co.

H. F. Shepherd will return shortly to the Bessemer Gas Engine Co. as chief engineer in the oil-engine department.

E. E. Hill, electrical engineer, has been recently appointed superintendent of the meter department of the New York Edison Co.

Francis B. Longrey, formerly with the Dow Pump & Diesel Engine Co., is now consulting engineer, 3623 Grand Ave., Oakland, Calif.

A. A. Meyer, assistant general superintendent of The Detroit Edison Co., has been recently transferred to the research department of that company.

Mark Albertson, a member of the Tariff Commission's engineering staff, has returned from abroad where he has been investigating production costs of magnesite and of fluorspar.

W. L. Batt, president of the SKF Industries, Inc., has been decorated by the King of Sweden with the knighthood of the Order of Vasa, first class.

Henry Fairchild, for many years well known to power-plant equipment men throughout the South, is now president of the Fairchild & Littlefield Co., manufacturers of power plant machinery at Greenville, S. C.

Prof. J. Stumpf, inventor of the Stumpf uniflow engine, is visiting this country. On Sept. 23 he delivered a lecture on the uniflow engine before the engineering students of Princeton University. Doctor Stumpf is stopping at the Hotel Commodore, New York City.

Ben E. Torpin, engineer who was in charge of construction of the Lake Cushman dam project of the Tacoma, Wash., municipal water power system, will be engaged as field engineer for the construction of the Bear Creek basin dam on the Bull Run River near Portland, Ore.

George L. Bascome, former consulting engineer in public-utility circles and in the coal fields of northeastern Pennsylvania, has recently become affiliated with the National Valve & Manufacturing Co., of Pittsburgh, Pa., manufacturers and contractors for high-pressure steam piping systems. Mr. Bascome will travel the entire country in the capacity of contact engineer.

Business Notes

The Bend Water, Light & Power Co., Bend, Ore., changed the name on Sept. 1, to Deschutes Power Co.

W. B. Foshay Co., which has its central office in the Foshay Bldg., Minneapolis, Minn., has appointed C. H. Burnworth manager of the Portland office of the securities sales department.

The Illinois Power & Light Co. has acquired the services of William H. Matlack as sales manager of the East St. Louis branch. Mr. Matlack succeeds Samuel C. Schmulback, who is leaving to become district manager of the Cairo branch.

The Kirk & Blum Manufacturing Co. of Cincinnati, designing engineers and manufacturers of pneumatic dust collecting, ventilating and conveying systems, announce the doubling of their plant facilities through the purchase of an adjoining factory.

The American Brown Boveri Electric Corp. announces that F. L. Townsend has been transferred to the New York office to conduct the sales of automatic voltage regulators, current limiting regulators, and automatic synchronizers, as well as other central-station equipment.

The Ton-Tex Corp., manufacturer of Ton-Tex belting, has been incorporated under the laws of the State of Michigan. This company will manufacture a thin duck composition belt for transmission and conveying purposes. The main sales offices and stockrooms of the company are at 345-351 West 35th St., New York City.

Trade Catalogs

Gate Valves—Ohio Brass Co. is announcing through an illustrated folder the new O-B Flexitite disk gate valve. This valve is one-piece casting, including the boss which threads on the stem. It shuts off tight on steam, water, oil, etc.

Conoidal Fans—The Buffalo Forge Co., Buffalo, N. Y. Catalog No. 475 deals with "baby" conoidal fans, giving ratings with the duplex turbo, and Niagara wheel. Construction details, dimensions and uses are also enumerated.

Valves—The Homestead Valve Manufacturing Co., Homestead, Pa., has issued a small booklet on the valve products of the company, entitled "Valve Economy." The principle of the Homestead makes is explained and illustrated. Listing and depicting is made of the brass straightway valves, acid-resisting metal, three- and four-way valves, semi-steel straightway, lubricated, and full round opening valves. Pictures of installations are also given.

Variable Speed Blowers—The L. J. Wing Manufacturing Co., manufacturers of forced draft equipment, unit heaters, etc., have recently published a new bulletin, No. 36 on their motor-driven forced draft units.

This new bulletin explains how Wing motor-driven blowers can be used with low pressure heating boilers, so that low cost buckwheat coal can be burned. Different types of installations with various kinds of heating boilers, both brick-set and cast-iron, are described and well illustrated. Tables of capacities at various static pressures and dimensions are included.

Motor Control Apparatus — The Cutler-Hammer Manufacturing Co., Milwaukee, Wis., has issued a publication which tells the story of the development of motor control apparatus. After showing that the consumption of electricity for industrial purposes has increased 3,000 per cent since 1905, the book points out the progress that has likewise been made in electrical equipment, particularly in motors and motor-control appliances. Then it gives numerous examples of the accomplishments of correct motor-control equipment. Many photographs of actual installations are shown.

Coming Conventions

American Electric Railway Engineering Association. Annual Meeting at Cleveland, Ohio, Oct. 4-8. Papers in power field Oct. 7. J. W. Welsh, 292 Madison Ave., New York City.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Regional meeting at Richmond, Va., Sept. 27-30.

American Welding Society. Annual Fall Meeting, at Buffalo, N. Y., Nov. 16-19. Gideon W. Swan, general chairman. First International Welding Exposition will be held in conjunction with meeting.

Association of Edison Illuminating Companies. Chateau Frontenac, Quebec, Sept. 27-Oct. 1. P. S. Millar, 80th St. and East End Ave., New York.

Empire State Gas and Electric Association. Lake Placid Club, N. Y., Sept. 30-Oct. 1. C. H. B. Chapin, Grand Central Terminal, New York.

National Association of Practical Refrigerating Engineers. Annual Convention and Exhibition at Kansas City, Mo., Nov. 2-5. Edward H. Fox, secretary, 5707 W. Lake St., Chicago, Ill.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Divisional meeting on the following date: Kansas Section at Manhattan, Kan., Oct. 14-16; H. Lee Jones, secretary, 401 National Reserve Bldg., Topeka, Kan.

National Exposition of Power and Mechanical Engineering, Fifth Annual Exposition at Grand Central Palace, New York City, Dec. 6-11.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Sept. 20 1926
Pool 1	New York	$2.40@$2.75
Smokeless	Boston	2.70
Clearfield	Boston	2.00@ 2.75
Somerset	Boston	1.90@ 2.00
Kanawha	Columbus	1.60@ 1.85
Hocking	Columbus	1.40@ 1.75
Pittsburgh	Pittsburgh	1.90@ 2.10
Pittsburgh gas slack	Pittsburgh	1.35@ 1.45
Franklin, Ill.	Chicago	2.35@ 2.50
Central, Ill.	Chicago	2.15@ 2.25
Ind. 4th Vein	Chicago	2.15@ 2.35
West Ky.	Louisville	1.10@ 1.40
S. E. Ky.	Louisville	1.50@ 1.85
Big Seam	Birmingham	1.75@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	2.10@ 3.50
Buckwheat No. 1.	Philadelphia	1.85@ 2.75
Birdseye	New York	1.25@ 2.00

FUEL OIL

New York—Sept. 23, light oil, tank-car lots; 28@34 deg. Baumé, 6c. per gal.; 36@40 deg., 6¾c. per gal. f.o.b. Bayonne, N. J.

St. Louis — Sept. 15, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.20 per bbl.; 26@28 deg., $2.25 per bbl.; 28@30 deg., $2.30 per bbl.; 30@32 deg., $2.35 per bbl.; 32@36 deg., gas oil, 6.15c. per gal.; 38@40 deg., 7.75c. per gal.

Pittsburgh—Sept. 14, f.o.b. local refinery; 30@34 deg., fuel oil, 5.87½c. per gal.; 36@40 deg., fuel oil 6½c. per gal.

Dallas—Sept. 22, f.o.b local refinery 26@30 deg., $1.70 per bbl.

Philadelphia—Sept. 16, 27@30 deg. $2.52@$2.58 per bbl.; 13@19 deg., $1.59 @$1.65 per bbl.

Cincinnati — Sept. 20, tank-car lots f.o.b. local refinery, 24@26 deg., Baumé, 6½c. per gal.; 26@30 deg., 6¾c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Sept. 13, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.45@$1.50 per bbl.; 26@30 deg., $1.60@$1.65; 30@32 deg., $1.80.

Boston—Sept. 20, tank-car lots f.o.b. 12@14 deg. Baumé 4.75c. per gal.; 28@32 deg., 6c. per gal.

New Plant Construction

Calif., Long Beach — Home Ice Co., Anaheim Rd., awarded contract for 5 story cold storage plant, to C. Olcester, 415 21st St., San Bernardino, $90,200.

Calif., Los Angeles—C. E. Bentley, Title Insurance Bldg., had plans prepared for the construction of 12 story, apartment on Wilshire Blvd. and Kingsley Ave. Estimated cost $1,000,000. L. L. Smith, City Club Bldg., is architect.

Calif., Santa Barbara—Interests c/o D. Blankenhorn, Pacific Mutual Bldg., plan hotel, at Montecito Park. Estimated cost $1,000,000.

Calif., Woodland — Reclamation Dist. 2068, will soon award contract for the construction of 4 pumping plants, etc, here. F. C. Hermann, Merchants Exchange Bldg., San Francisco, is engineer.

Conn., Mansfield-Storrs—State awarded contract for the construction of 2 pumping stations, etc, at Connecticut Agricultural College and Mansfield State Training School here, to Interstate Constr. Co., 37 South Front St., New Haven. Estimated cost $145,000.

D. C., Washington — U. S. Engineers Office, War Department, will receive bids until September 30th, furnishing, installing, and testing 2 generators, automatic switchboard, etc., for District of Columbia Water Supply.

Ga., Albany—City plans election in fall to vote $10,000 for pumps, $20,000 for artesian well, etc. Total $187,000.

Ill., Aurora — Aurora Building Corp., awarded contract for the construction of 19 story, hotel at Island Ave. and Main St., to H. G. Christman & Co., 2007 East Jefferson St., South Bend, Ind. Estimated cost $1,750,000. Three elevators will be installed.

Ill., Chicago—Edgewater Athletic Club, 105 West Monroe St., F. A. Harkness, Secy., will receive bids about October 1st, for the construction of 15 story club, with one 75 and one 30 ton refrigeration machines, 2 passenger and 1 freight elevators, three 200 hp. Heine type boilers, etc. at Sheridan Rd. and Ardmore Ave. Estimated cost $3,500,000. P. Garhardt, 64 West Randolph St., is architect.

Ill., Chicago—J. J. Glasser, 4826 Sheridan Rd., awarded contract for the construction of 7 story apartment hotel, at 6137-39 Kenwood Ave., to Reliance Co., Inc., 11 South La Salle St. Estimated cost $650,000.

Ill., Chicago—D. S. Klafton, Archt., 64 West Randolph St., will receive bids until October 5, for construction of 8 story apartment hotel, with refrigeration system, at 4539 Sheridan Rd., for J. A. Bidderman, 10 South La Salle St. Noted Aug. 24.

Ill., Chicago—J. Kulp, 33 South LaSalle St., is having preliminary plans prepared for the construction of 20 story office and stores buildings, at Wabash Ave. and East Harrison St. Estimated cost $3,000,000. A. S. Alschuler, 28 East Jackson Blvd., is architect.

Ill., Chicago—W. Reichert, Archt., 35 South Dearborn St. awarded contract for the construction of 17 story hotel on South Shore Dr., between 55th and 56th Sts., to J. A. Lundstrum, 1034 East 48th St., for Flamingo Hotel Corp. Estimated cost $1,000,000.

Ill., Decatur—City Sanitary Sewerage District will receive bids until about October 27, for the construction of complete sewerage system, including disposal plant, with pumping equipment, etc. Pearse, Greeley & Hanson, 6 North Michigan Ave., Chicago, are engineers.

Ill., Kankakee—Kankakee Building Corp. will receive bids until October 5, for the construction of superstructure of 3 story office, stores, apartment and theatre building, with cooling plant, etc. at Dearborn Ave. and Merchants St. Estimated cost $600,000. Hooper & Janusch, 879 North State St., Chicago, are architects.

Ia., Cedar Rapids—Krenn & Dato, 936 North Michigan Ave., awarded contract for 12 story, 40 x 140 ft. hotel, to O. F. Paulson Constr. Co. Estimated cost $1,250,000.

Ia., Eldora—City, W. H. Soper, Mayor, plans the construction of waterworks, including pumping equipment, etc. L. Higgins, 420 Security Bldg., Des Moines, is architect.

Kan., Coffeyville—City will soon receive bids for 3,000 kw. turbine for electric light and power plant, here. Estimated cost $70,000. T. R. Marshall, is engineer.

La., Baton Rouge—W. H. Williams, 816 Howard Ave., New Orleans, will build 13 story hotel. Estimated cost $1,000,000. Work will be done by separate contracts.

Md., Baltimore—Medical Arts Building Corp., c/o M. E. Wright, American Natl. Bank Bldg. Archt., awarded contract for the construction of 8 story office and stores building at Cathedral and Richmond Sts., to L. Pascall, Vermont Bldg., Richmond, Va. $800,000.

Mass., Arlington—Arlington Gas Light Co., 689 Massachusetts Ave., awarded contract for the construction of 2 story boiler house and generator building, on Grove St., to Arlington Construction Co., 313 Broadway. Estimated cost $60,000.

Mass., Charlestown (Boston P. O.)—W. F. Schrafft & Sons Corporation, 160 Washington St., N., Boston, awarded contract for the construction of 6 story, 200 x 480 ft. factory addition and power house, at Medford St. and Sullivan Sq., to Turner Constr. Co., 178 Tremont St., Boston. Estimated cost $1,500,000.

Mass., Dorchester (Boston P. O.)—City Transit Dept., 1 Beacon St., Boston, will receive bids until October 5, for the construction of a sub power station, on Dickens St. E. F. Springer, 1 Beacon St., is engineer.

Mo., Malta Bend—Malta Bend Levee District, is having plans prepared for levee work and constructing pumping plant, near here. C. R. Jacoby Eng. Co., Interstate Bldg., Kansas City, is engineer.

Mo., St. Louis—Colonial Laundry Co., 4020 Olive St., is in the market for 125 to 175 kw., 115 v., d.c., direct connected 125 steam pressure electric unit.

N. H., Manchester—Manchester Traction Light & Power Co. awarded contract for repairing 600 ft. dam, constructing power house, spillway, etc. and installing 2,200 hp. turbines to Morton C. Tuttle Co., 862 Park Sq. Bldg., Boston, Mass.

N. J., Jersey City—Erie R.R. Co., 50 Church St., New York City, plans group warehouse buildings including cold storage plant at 11th and 12th Sts., here. Estimated cost $3,000,000. R. C. Falconer is chief engineer.

N. J., Newark—Merchants Refrigerating Co., 17 Varick St., New York City, plans the construction of cold storage warehouse, at Pennsylvania R.R. tracks and Vanderpool Ave. Estimated cost $1,500,000. Private plans.

N. Y., New York — A. E. Lefcourt, 359 Bway., will build 25 story, office and stores building with 4 electric elevators, at 65 Broad St. Work will be done by separate contracts under supervision of Buchman & Kahn, 49 West 45th St., architects.

N. Y., New York—Rosman Constr. Co., c/o Murgatroyd & Ogden, Engrs. and Archts., 286 Madison Ave., will build 17 story apartment, with 2 electric elevators, at Gramercy Park, South and Irving Pl. Estimated cost $500,000. Work will be done by day labor.

N. Y., New York—Thomas Holding Corporation, 32 East 19th St. awarded contract for the construction of 16 story apartment, at foot of East 52nd St., to T. E. Rhoades Constr. Co., Inc., 342 Madison Ave. Estimated cost $500,000.

N. Y., New York—P. Uris, 50 West 42nd St., will build office and stores building at 269 Madison Ave. Estimated cost $800,000. Work will be done by separate contracts under owner's supervision.

N. Y., Solvay—E. M. Hall, Village Clerk will receive bids until September 28, for centrifugal pump, driven by gas engine for Bd. Trustees.

O., Dayton—Constructing Quartermaster, Wright Field, rejected bids on September 9, for the construction of boiler house, with mechanical equipment, etc., at Wright Field, here.

Okla., Bokoshe—City is having preliminary plans prepared for the construction of waterworks system, including deep well pump. Estimated cost $20,000. Gantt-Baker Co., 1116 West Main St., Oklahoma City, is engineer.

Okla., Paden—City is having plans prepared for the construction of waterworks including deep well pump, etc. Estimated cost $24,000. Engineer not announced. G. Ware is city clerk.

Pa., Brackenridge—Brackenridge Boro, G. H. Dickey, Secy., will receive bids until October 5, for 1 centrifugal pumping unit, having bronze impellers, bronze covered steel shaft, and thrust bearing; pump to be designed for 1,400 g.p.m. against a total dynamic head of 335 ft. including 14 ft. suction lift, to handle water from Allegheny River after screening.

Pa., Pittsburgh—Aiken Apartments Corp., 606 Commonwealth Bldg., is having plans prepared for the construction of 9 story apartment with elevators and vapor heating system, at Center and Aiken Sts. Estimated cost $1,000,000. Kichnel, Ellicott & Chalfont, 4044 Jenkins Arcade, are architects.

Pa., Pittsburgh—Stanley Roland Clark Corp., State Theatre Bldg., awarded contract for 23 story theatre and office building, with elevators, at 7th St. and Penns Ave., to W. T. Grange, Constr. Co., Keenaw Bldg. Estimated cost $4,000,000.

S. D., Watertown—City is having plans prepared for the construction of additions and improvements to power plant, including 1,500 kw. turbine. A. L. Mullergren, 765 Bd. Trade Bldg., Kansas City,, Mo., is engineer.

Va., Norfolk—Virginia Electric & Power Co. awarded contract for the design and construction of 1st unit power plant here, to Stone & Webster, 120 Broadway, New York City. Estimated cost $2,500,000.

Tex., Boerne — City plans an election October 11, to vote $60,000 bonds for constructing waterworks, etc., including pumping equipment.

Tex., Brownsville — City plans election October 16, to vote $35,000 bonds for constructing extensions to light plant. Machinery and equipment will be purchased.

Tex., Crystal City—Texas Central Power Co., Frost Bldg., San Antonio, awarded contract for the construction of 56 x 206 ft. ice plant, to Sumner-Sollitt Co., National Bank of Commerce Bldg. Estimated cost $125,000.

Tex., Galveston — Boulevard Hotel Co. will receive bids after November 1st, for the construction of 12 story, hotel, with 4 elevators, here. Estimated cost $1,300,000. P. G. Silber & Co., 332 Bedell Bldg., San Antonio, are architects.

Tex., Galveston—Medical College, University of Texas, c/o J. W. Calhoun, Austin, is receiving bids for remodeling heating system, at University Hall, including new boiler, pumps, etc.

Tex., Houston — B. V. Christie, Great Southern Life Bldg., E. A. Singer, 1st Natl. Life Bldg., et al., are having plans prepared for the construction of 10 story hotel, with elevators and steam heating system at Prairie Ave. and Main St. Estimated cost $500,000. J. Finger, 711 Keystone Bldg., is architect.

Tex., McAllen—Valley Electric & Ice Co., Brownsville, is having preliminary plans prepared for the construction of 75 to 100 ton electrically driven ice plant. Estimated cost $200,000; also for electric substation. Estimated cost $60,000. Private plans. New machinery will be installed at both projects.

Wis., Cedarburg—Framm Bros., Nieman & Co., J. F. Nieman, Mgr., will build 2 story cold storage plant. Estimated cost $100,000. Work will be done by day labor. Owner is in the market for refrigeration machinery.

Que., Montreal—Sun Life Assurance Co. of Canada, Dominion Sq. will soon receive bids for the construction of office building at Mansfield and Metcalf Sts. Estimated cost $2,500,000. D. L. Macaulay, is secretary.

B. C., Nelson—West Kootenay Power & Light Co., Bonnington Falls, is having plans prepared for 60,000 hp. hydro electric development, in Kootenay River, at Bonnington Falls, near here. Estimated cost $3,000,000.